ANACARDIUM OCCIDENTALE

THE
WEALTH OF INDIA

A Dictionary of Indian Raw Materials and Industrial Products

DELHI

1948

THE
WEALTH OF INDIA

RAW MATERIALS

VOL. I

FOREWORD

" The Wealth of India "—what a vision of past history and splendour it brings, when the Indies attracted adventurers in search of wealth and fortune from the most distant countries ! Yet all the world knows that India is full of poverty-stricken people today. Nevertheless, India is wealthy and the wealth of India is there. But in spite of this wealth, the people are poor. The problem for us is to utilize this stored-up wealth of the country in the soil and under the soil, for the benefit of Indian humanity. This book is a kind of encyclopædia or dictionary, and dictionaries seldom make attractive reading. But I have found this particular dictionary rather fascinating and it has opened out vistas of thought to me. The pictures are good.

I have no doubt that this book, produced by many scholars and experts and after much labour, will be of great value to the builders of new India. It should be of value also in educating the average citizen, who should take interest in this fascinating land and its enormous potentialities.

Jawaharlal Nehru

NEW DELHI ;
21st December, 1948.

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Kashyapa, K.	17th Jan., '48	
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Jayarama Sarma, S.	11th Mar., '47	

INTRODUCTION

The Dictionary of the Economic Products of India, and the Commercial Products of India, published by George Watt in 1889-99 and 1908, respectively, still remain the only standard works of reference on the economic resources of India. The period following their publication has been one of rapid changes, especially after the First World War. The phenomenal advancement of science and numerous systematic studies have been responsible for the accumulation of a vast amount of knowledge about the resources of India. The period has also witnessed enormous changes in the political, economic and industrial structure of the country.

Several proposals were put forward from time to time to publish revised editions of Watt's works, incorporating all the recent developments and accumulated knowledge. The necessity for a new edition was felt acutely during the last war, and the proposal sponsored by Dr. S. S. Bhatnagar, and Lala Shri Ram, for producing an up-to-date Dictionary of Raw Materials, under the auspices of the Council of Scientific and Industrial Research, was accepted by its Governing Body in April 1942. The Governing Body then appointed an Advisory Board and the Editorial Staff.

The Advisory Board met in the early part of 1943 and discussed the general principles which should guide the work. They directed that, in view of the urgent need for developing the latent resources of the country, the scope of the Dictionary should be expanded to include Indian industries and industrial products, in addition to raw materials. The Board then appointed an Editorial Committee for the technical and administrative supervision of the work of compilation.

The Editorial Committee, after careful deliberation, issued the following directions to the Chief Editor :

1. The Dictionary should include all the economic products and industrial raw materials of India, a separate volume being devoted to Indian industries and industrial products.

2. The arrangement should be alphabetical, using scientific nomenclature. Common English names, when listed, should be provided with cross references to their scientific equivalents. Indian names should be confined to the major languages of the country, regional names being given only when the subjects are of restricted occurrence.

3. The articles should be based on published materials only, and should include selected references to literature. Sections on pure science should be very brief. Also, the processing of any material, and the manner in which it is utilized, should receive brief treatment.

4. Sections on statistics should contain a critical account of published data.

5. Historical and descriptive material should be brief. In general, the articles should be concise, and the maximum length of a major topic should not exceed 50 foolscap pages of double-spaced typescript.

6. Well-known botanical subjects need not be elaborated, but they should be provided with references to sources of information.

7. Specialists may be invited to contribute articles on important topics.

The Editorial Committee then appointed Sub-Committees for guiding the work of the various sections of the Dictionary, and the Chief Editor has been able to enlist the co-operation of several colleagues in various parts of the country, to act as regional correspondents.

The new Dictionary has been named *The Wealth of India*. The present publication is the First Volume on Raw Materials. The attempt has been to give a critical resumè of literature, economic, scientific and statistical, with special reference to utilization.

In the case of botanical subjects, the scientific name of the genus forms the title of each article, and is followed by a brief account of the genus. The important economic species are described in the alphabetical order of their scientific names. Where the name given in the Flora of British India, or Watt's Dictionary, remains unchanged, no synonyms are added. A new name, if it has not yet come into general use, is given as the equivalent of the one employed in the text. When new names are used, the names used by Hooker or Watt are given as synonyms.

After the title, the common English name, if any, and the standard references are given. Names in Indian languages are from regional floras, and published lists of Indian names. No attempt is made to give a botanical description of either the genus or the species. The parts of economic importance, however, are described adequately. Where the species are of minor importance, a short generic note is considered sufficient. The distribution given is according to standard Indian floras. Purely ornamental or horticultural plants are not included.

For minerals and animal products, their common names have been found more convenient. Articles on minerals have been scrutinised by the Geological Survey of India, and occurrences have been listed in greater detail, owing to absence of much information regarding reserves.

The information collected for the various articles of the Dictionary is carefully documented and filed in ledgers in the office. In the case of subjects of topical interest articles based on these ledgers are sent for publication in current journals and periodicals. Besides, the ledgers are kept 'alive' by the continual addition of fresh published information to facilitate revision of the text. It is expected that this accumulated

information will prove helpful to all future enquiries on Indian economic and industrial products.

A list of external contributors of articles for this volume is appended. The articles received from contributors have been edited and modified to conform to the standard form adopted for the Dictionary.

Grateful acknowledgment is here made in the name of Indian Economy and Science to the willing co-operation which has been extended to this work by several institutions, technical authorities, specialists, and Government Departments, in India, as well as abroad. The sources of information have been numerous, and it is impossible to thank every one individually. The Chief Editor hesitates to make any special mention as every one, whom he has approached for help, has been equally responsive.

The Chief Editor desires to express his gratitude to Dr. S. S. Bhatnagar, for having given him an opportunity to participate in this work, and to each of the members of the Editorial Committee for invaluable help, guidance and criticism, throughout the course of this compilation.

Further, the Chief Editor desires to place on record his grateful appreciation of the unstinted labour and loyal co-operation of his colleagues and staff.

Suggestions for improvement, and additional information will be gratefully received and made use of in subsequent editions.

B. L. MANJUNATH,
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TO THE READER

1. In each article references are given to Watt's Dictionary of Economic Products (D. E. P.), and Commercial Products (C. P.). In the case of botanical subjects references are given to Hooker's Flora of British India (Fl. Br. Ind.), or some other standard flora.

2. References to plates in the volume are indicated at appropriate places in the text. In the case of others, complete citations are made.

3. Names of species listed are followed by those of their authors. In the text, authors' names are included only for plants (Indian or foreign), not dealt with as separate items in the Dictionary.

4. Books, journals and periodicals referred to are listed elsewhere. The abbreviated titles generally conform to those adopted in the World List of Scientific Periodicals (1934). In the case of books, the author's name is followed by the page reference. When two or more books by the same author are referred to, the year of publication is given immediately after the author's name. After the title of a journal, the year of issue, volume No. (thick type) and of part, if any (1.e. roman numerals), and page No. are listed successively.

5. A careful selection of references has been made and these are usually inserted at the most convenient points in the article, though they have been made use of in a more general manner.

6. In general, literature up to the end of 1945 has been consulted. In the case of some articles, however, information published later, has been added during the proof stage.

7. Unless otherwise stated, statistical information has been taken from official sources, such as the publications of the Department of Commercial Intelligence, and the Central Marketing Department.

8. A list of the less familiar abbreviations and symbols is added for the benefit of the general reader. The others employed are as per the Dictionary of Abbreviations by C. C. Matthews (1947).

9. Temperatures, unless otherwise specified, always refer to the Centigrade scale.

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Das Gupta, S. M., Delhi Polytechnic Institute, Delhi .	*Acacia senegal* Willd.
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—do—	Building Stones
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Mukherjee, S. K., Royal Botanic Garden, Calcutta .	*Berberis*
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Sahni, M. R., Geological Survey of India . . .	Alkaline Soils & Lakes
—do—	Borax
Sálim Ali, C/o Bombay Natural History Society, Bombay.	Birds associated with Agriculture and Horticulture
—do—	Edible Birds : Ducks, Teals, Geese, Swans, Storks, etc.
—do—	Pheasants, Jungle-fowl, Partridges, etc.
—do—	Edible Birds' Nests
Sastri, S. G., Retd. Director of Industries and Commerce, Mysore, Bangalore.	*Artemisia pallens* Wall ex DC.
—do—	*Bursera* Linn.
Yogna Narayan Aiyer, A. K., Retd. Director of Agriculture, Mysore, Bangalore.	*Areca catechu* Linn.

LIST OF ILLUSTRATIONS

Plate No.	Description	Acknowledgment
XII	1. *Aleurites montana*	Dr. S. D. Choudhury, Assam.
	2. Fruits of *A fordii*	Silviculturist, For. Res. Inst., Dehra Dun.
	3. ,, *A. montana*	
	4. Greater Cardamom (*Amomum subulatum*)	
	5. Lesser Cardamom (*Elettaria cardamomum*)	
XIII	1. *Alstonia scholaris*	Govt. of Mysore.
	2. *Amaranthus blitum*	,,
	3. *Amaranthus spinosus*	,,
XIV	1. *Anagallis arvensis*	,,
	2. *Andrographis paniculata*	,,
	3 *Anisomeles malabarica*	,,
XV	1. *Anogeissus latifolia*	,,
	2. *Annona reticulata*	,,
	3. *Annona squamosa*	,,
XVI	1. Groundnut (*Arachis hypogea*)—Runner type	The Central Agric Marketing Dep.
	2. Groundnut –Bunch type	,,
	3. Coromandel	Mr. C. M. John, Coimbatore.
	4. Bold	,,
	5. Peanuts	,,
	6. Red Natal	,,
XVII	1. *Aristolochia indica*	Govt. of Mysore.
	2. *Artabotrys odoratissimus*	,,
	3. *Asteracantha longifolia*	,,
	4. *Averrhoa carambola*	,,
XVIII	1. *Artemisia pallens*	
	2. *A. maritima*	Col. R. N. Chopra, Jammu.
	3. *A. maritima forma rubricaule*, grown in Dehra Dun	Silviculturist, For. Res. Inst., Dehra Dun.
	4. *A. maritima* growing wild in Gurais Valley, Kashmir	Col. R. N. Chopra, Jammu.
XIX	1. a. A bunch of areca nuts (*Areca catechu*)	Supt., Govt. Museum, Madras.
	b. A whole nut	,, ,,
	c. A shelled nut	,, ,,
	2. Bread fruit (*Artocarpus communis*)	
	3. Jack tree (*Artocarpus integra*)	Supt , Govt. Museum, Madras.
	4, Cross section of jack fruit	,, ,,

Plate No.	Description	Acknowledgment
XX	1. Burmese amber (burmite)	Director, Geol. Surv., India.
	2. Asbestos from Seraikela	,, ,,
	3. A block of asbestos	Principal, Indian School of Mines, Dhanbad.
	4. Veins of asbestos	Director, Geol. Surv., India.
XXI	1. *Atropa acuminata*	Col. R. N. Chopra, Jammu.
	2. *A. belladonna*	,, ,,
	3. Belladonna roots (*A. acuminata*)	,, ,,
	4. *Avena byzantina*	Dr. B. P. Pal, New Delhi.
	5. *A. sativa*	,, ,,
XXII	1. *Azadirachta indica*	Govt. of Mysore.
	2. *Azima tetracantha*	,,
	3. *Bacopa monniera*	,,
	4. *Balanites aegyptiaca*	,,
XXIII	1. *Bambusa arundinacea*	Silviculturist, For. Res. Inst., Dehra Dun.
	2. *Dendrocalamus strictus*	,,
	3. *Ochlandra travancorica*	,,
	4. *Dendrocalamus strictus*, longitudinal section through a vascular bundle. 1. Fundamental tissue ; 2. pitted vessel ; 3. mechanical fibres ; 4. groups of sieve tubes with companion cells ; 5. paratracheal parenchyma	The Technical Press, Ltd., Surrey, and The Wood Technologist, For. Res. Inst., Dehra Dun.
XXIV	1. *Barleria prionitis*	Govt. of Mysore.
	2. *Bauhinia variegata*	,,
	3. *B. vahlii*	,,
XXV	1. Barytes deposit in Cuddapah Dist. (*vide* Barium minerals)	Director, Geol. Surv., India.
	2. Indian bauxite (pisolitic)	,, ,,
	3. Beryl	,, ,,
XXVI	1. *Barringtonia asiatica*	Govt. of Mysore.
	2. *Berrya cordifolia*	,,
XXVII	1. Bees : *Apis indica*, Queen (1), Worker (2), and Drone (3), Workers of *A. millifica* (4), *A. dorsata* (5), *A. flora* (6), and *Melipona* spp. × 2 (7)	
	2. Crushed bones (left) ; bone meal and bone grist (centre) ; and bone sinews (right)	
	3. Bristles before dragging (left) ; and dressed bristles (centre and right)	
	4. Bone ornaments	

Plate No.	Description	Acknowledgment
XXVIII	Birds :	
	1. Common teal ; 2. Grey partridge ; 3. Grey quail ; 4. Grey jungle fowl ; 5. Monal pheasant ; and 6. Blood pheasant.	Mr. Sálim Ali, Bombay.
XXIX	Birds :	
	1. Rosy pastor ; 2. Shama ; 3. Black drongo ; 4. Indian roller ; 5. Shahin falcon ; and 6. Edible nest swiftlet and nests.	,,
XXX	1. *Benincasa hispida* .	
	2. *Berberis aristata* .	Supt., Royal Bot. Gdn., Calcutta.
	3. *B. asiatica* . .	
	4. *B. lycium* . .	
XXXI	*Bixa orellana* . .	Govt. of Mysore.
XXXII	1. *Borassus flabellifer*	Curator, Industr. Section, Indian Museum, Calcutta.
	2. Bunch of Palmyra fruits and cross-section of a fruit (inset)	Dr. G. S. Siddappa, Coimbatore.
	3. *Boswellia serrata*	Silviculturist, For. Res. Inst., Dehra Dun.
	4. *Broussonetia papyrifera*	
XXXIII	1. *Sarson* (*Brassica campestris* var. *sarson*) .	
	2. *Toria* (*B. campestris* var. *toria*). . .	
	3. *Rai* (*B. juncea*)	
	4. *Benarasi rai* (*B. nigra*)	
XXXIV	1. Cabbage (*Brassica oleracea* var. *capitata*)	
	2. Cauliflower (*B. oleracea* var. *botrytis*). .	
	3. Brussels sprouts (*B. oleracea* var. *gemmifera*)	
	4. Knol-Kohl (*B. oleracea* var. *gongylodes*) .	
	5. Turnip (*B. rapa*).	
XXXV	1. *Boswellia serrata*	Govt. of Mysore.
	2. *Bryophyllum pinnatum*	,,
XXXVI	*Butea monosperma*	,,
XXXVII	1. Sandstone cliffs	Director, Geol. Surv., India.
	2. Soapstone	,,
	3. Limestone quarry	The Min. Geol. Metall. Inst., India, Calcutta.
	4. Marble quarry	
XXXVIII	Granites from Mysore . .	Director, Geol. Dep., Mysore.

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Author	Year	Title
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Chhibber, H. L.	1934	The Mineral Resources of Burma.
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AUTHOR	YEAR	TITLE
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Firminger, T. A.	1947	Manual of Gardening for India.
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Hill, A. F.	1937	Economic Botany.
Jacobs, M. B.	1944	The Chemistry and Technology of Food and Food Products. 2 Vols.
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Popenoe, W.	1920	Manual of Tropical and Sub-tropical fruits.
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Ramakrishna Ayyar, T. V.	1940	Handbook of Economic Entomology for South India.
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Ramaswami, S.	1936	Indian Woods Tested for Match Manufacture.
Reese, A. M.	1942	Outlines of Economic Zoology.
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Rodger, A.	1943	A Handbook of the Forest Products of Burma.
Rogers, A.	1942	Manual of Industrial Chemistry. 2 Vols.
Sálim Ali	1944	The Book of Indian Birds.
Sircar, J. K.	1945	Memorandum on Indian Fibres other than Jute and Cotton.
Sollmann, T.	1942	Manual of Pharmacology.
Stewart, J. L.	1869	Punjab Plants.
Talbot, W. A.	1909–11	Forest Flora of Bombay Presidency and Sind. 2 Vols.
Trease, G. E.	1945	A Textbook of Pharmacognosy.
Tressler, D. K.	1940	Marine Products of Commerce.
Trivedi, A. B.	1943	The Wealth of Gujarat.
Trotter, H.	1940	Manual of Indian Forest Utilization.
	1944	The Common Commercial Timbers of India.
Troup, R. S.	1921	The Silviculture of Indian Trees. 3 Vols.

Author	Year	Title
Wehmer, C.	1929–31	Die Pflanzenstoffe. 2 Vols.
	1935	Supplement.
Willis, J. C.	1931	A Dictionary of the Flowering Plants and Ferns.
Winton, A. L. and Winton, K. B. . .	1939	The Structure and Composition of Foods. 4 Vols.
Wren, R. C.	1941	Potter's Cyclopaedia of Botanical Drugs and Preparations.
Yegna Narayan Aiyer, A. K. . . .	1944	Field Crops of India.

Abbreviated Title	Year	Title
B. P.	1932	The British Pharmacopoeia.
B. P. C.	1934	The British Pharmaceutical Codex.
C. P.	1908	Watt, G. : Commercial Products of India.
D. E. P.	1889–99	Watt, G. : A Dictionary of the Economic Products of India. 6 Vols.
Fl. Assam	1934–40	Kanjilal, U. N., Kanjilal, P. C., *et al.* Vols. I-IV. Bor, N. L., Vol. V.
Fl. Br. Ind.	1872–97	Hooker, J. D. : Flora of British India. 7 Vols.
Fn. Br. Ind.	1928	Stuart Baker, E. C. : Fauna of British India. Birds.
I. P. L.	1946	The Indian Pharmacopoeial List.
Kingzett	1945	Kingzett's Chemical Encyclopaedia.
Kirt. and Basu	1935	Kirtikar, K. R., and Basu, B. D. : Indian Medicinal Plants. 4 Vols. and Plates.
Thorpe	1937–47	Thorpe's Dictionary of Applied Chemistry. 8 Vols.
U. S. P.	1942	The Pharmacopoeia of the United States of America.

JOURNALS REFERRED TO IN THE FIRST VOLUME

Agric. and Anim. Husb. India	Agriculture and Animal Husbandry in India.
Agric. J. India	Agricultural Journal of India, Pusa.
Agric. Ledger	Agricultural Ledger, Calcutta.
Amer. J. Pharm.	American Journal of Pharmacy, Philadelphia.
Ann. R. bot. Gdn. Calcutta	Annals of the Royal Botanic Garden, Calcutta.
Annu. Rep. Bd. Sci. Adv. India.	Annual Report of the Board of Scientific Advice for India, Calcutta.
Annu. Rep. Dep. Agric., N. W. F. P.	Annual Report of the Department of Agriculture, N.W.F.P.
Annu. Statt. Sea-borne Tr. India.	Annual Statement of the Sea-borne Trade of India.
Arch. Pharm., Berl.	Archiv der Pharmazie, Berlin.
Avicult. Mag., New Series	Avicultural Magazine, Brighton.
Ber. dtsch. chem. Ges.	Bericht der Deutschen Chemischen Gesellschaft, Berlin.
Bio-chem. J.	Bio-chemical Journal, Liverpool.
Bot. Gaz.	Botanical Gazette, Chicago.
Brit. chem. Abstr., B.	British Chemical Abstracts, B, Applied Chemistry.
Bull. Acad. Sci., Allahabad	Bulletin of the Academy of Sciences of the United Provinces of Agra and Oudh, Allahabad.
Bull. Dep. Industr. & Comm. U. P., New Series	Bulletin of the Department of Industry and Commerce, United Provinces.
Bull. imp. Inst., Lond.	Bulletin of the Imperial Institute, London.
Bull. imp. Inst. Agric. Res., Pusa	Bulletin of the Imperial Institute of Agricultural Research, Pusa.
Bull. Indian Industr. Lab.	Bulletin of Indian Industries and Labour.
Bull. Indian Industr. Res.	Bulletin of Indian Industrial Research.
Bull. Indian Soil Sci.	Bulletin of Indian Soil Science.
Bull. Minist. Agric., Lond.	Bulletin of Ministry of Agriculture and Fisheries, London.
Calcutta Geogr. Rev.	Calcutta Geographical Review.
Capital	Capital, Calcutta.
Chem. Abstr.	Chemical Abstracts, New York.
Chem. Age, Lond.	Chemical Age, London.
Chem. and Industr.	Chemistry and Industry, London.
Chem. Engng. News	Chemical and Engineering News.
Chem. Tr. J.	Chemical Trade Journal and Chemical Engineering, Manchester.
Curr. Sci.	Current Science, Bangalore.
Dep. Agric., Assam, Leafl.	Department of Agriculture, Assam, Leaflet.
Dep. Agric., Bengal, Leafl.	,, ,, Bengal, Leaflet.

Dep. Agric., Bihar & Orissa, Bull.	Department of Agriculture, Bihar and Orissa, Bulletin.
Dep. Agric., Bombay, Bull.	,, ,, Bombay, Bulletin.
Dep. Agric., Madras, Bull.	,, ,, Madras, Bulletin.
Dep. Agric., Mysore, Bull.	,, ,, Mysore, Bulletin.
Dep. Agric., Sind, Leafl.	,, ,, Sind, Leaflet.
Dep. Agric., U. P., Bull.	,, ,, U. P., Bulletin.
Dep. Agric. Sci., Union S. Africa, Bull.	Department of Agricultural Scienc., Union of South Africa, Bulletin.
Dep. Comm. U.S.A., For. Comm. Weekly	Department of Commerce, U. S. A., Foreign Commerce Weekly.
Dep. Industr., Bengal, Bull.	Department of Industry, Bengal, Bulletin.
Dep. Industr., Madras, Bull.	Department of Industry, Madras, Bulletin.
Dep. Land Rec. and Agric., Bengal, Bull.	Department of Land Records and Agriculture, Bengal, Bulletin.
Der Pflanzer	Der Pflanzer.
Endeavour	Endeavour, London.
For. Res. India and Burma.	Forest Research, India and Burma.
Gdns.' Bull.	Gardeners' Bulletin.
Helv. chim. Acta.	Helvetica Chimica Acta, Basel, Genf.
Hlth. Bull.	Health Bulletin, Delhi.
Hyderabad geol. Surv., Bull.	Hyderabad Geological Survey, Bulletin.
Imp. Coun. Agric. Res., Misc. Bull.	Imperial Council of Agricultural Research, Miscellaneous Bulletin.
Indian Bee J.	Indian Bee Journal.
Indian Fmg.	Indian Farming.
Indian For.	Indian Forester.
Indian For. Bull., New Series	Indian Forest Bulletin, New Series.
Indian For. Leafl.	Indian Forest Leaflet.
Indian For. Rec.	Indian Forest Records.
Indian For. Rec., New Series, Bot.; Chem.; Silv.; Util.	Indian Forest Records, New Series, Botany; Chemistry; Silviculture; Utilization.
Indian J. agric. Sci.	Indian Journal of Agricultural Science.
Indian J. Ent.	Indian Journal of Entomology.
Indian J. Genet. & Pl. Breed.	Indian Journal of Genetics and Plant Breeding.
Indian J. med. Res.	Indian Journal of Medical Research.
Indian J. Pharm.	Indian Journal of Pharmacy.
Indian J. vet. Sci.	Indian Journal of Veterinary Science and Animal Husbandry.
Indian med. Gaz.	Indian Medical Gazette.
Indian med. Res. Mem.	Indian Medical Research Memoirs.
Indian Soap J.	Indian Soap Journal.

Indian Text. J.	Indian Textile Journal.
Indian Tr. J.	Indian Trade Journal.
Industr. Engng. Chem.	Industrial and Engineering Chemistry, Eastern Pa.
Inland (Rail & River-borne) Tr. India.	Accounts relating to the Inland Rail and River-borne Trade of India.
Int. Yearb. agric. Statist.	International Yearbook of Agricultural Statistics, Rome.
J. agric. Res.	Journal of Agricultural Research, Washington.
J. Amer. chem. Soc.	Journal of the American Chemical Society, Eastern, Pa.
J. Amer. Pharm. Ass.	Journal of the American Pharmaceutical Association, Columbia.
J. Asiat. Soc. Bengal.	Journal and Proceedings of the Asiatic Society of Bengal.
J. biol. Chem.	Journal of Biological Chemistry, Baltimore.
J. Bombay nat. Hist. Soc.	Journal of the Bombay Natural History Society.
J. chem. Soc.	Journal of the Chemical Society, London.
J. Hered.	Journal of Heredity, Washington.
J. Hyderabad geol. Surv.	The Journal, Hyderabad Geological Survey.
J. Indian bot. Soc.	Journal of the Indian Botanical Society.
J. Indian chem. Soc.	Journal of the Indian Chemical Society.
J. Indian chem. Soc., Industr. & News Edn.	Journal of the Indian Chemical Society, Industrial and News Edition.
J. Indian Industr.	Journal of Indian Industries and Labour.
J. Indian Inst. Sci.	Journal of the Indian Institute of Science.
J. Malaria Inst., India	Journal of the Malaria Institute, India.
J. Mysore Univ.	Journal of the Mysore University.
J. Nutrit.	The Journal of Nutrition, Baltimore.
J. Osmania Univ.	Journal of Osmania University.
J. R. Soc. Arts.	Journal of the Royal Society of Arts, London.
J. sci. industr. Res.	Journal of Scientific and Industrial Research, India.
J. Siam. Soc., Nat. Hist. Suppl.	Journal of the Siam Society, Natural History Supplement.
J. Soc. chem. Ind., Lond.	Journal of the Society of Chemical Industry, London.
J. Soc. Dy. Co., Bradford	Journal of the Society of Dyers and Colourists, Bradford.
J. Univ. Bombay	Journal of the University of Bombay.
Kew Bull.	Bulletin of Miscellaneous Information (Royal Botanic Gardens, Kew), London.
Liebig's Ann.	Liebig's Annaleen der Chemie, Leipsig.
Madras Agric. J.	Madras Agricultural Journal.

Malay. agric. J.	Malayan Agricultural Journal, Kuala Lumpur.
Mem. Asiat. Soc. Bengal.	Memoirs of the Asiatic Society of Bengal.
Mem. Dep. Agric. India. Bot.	Memoirs of the Department of Agriculture in India. Botanical Series.
Mem. geol. Surv. India.	Memoirs of the Geological Survey of India.
Mon. Bull. Agric. Sci., Rome	Monthly Bulletin of Agricultural Science and Practice, Rome.
Mon. Bull. Bangalore Cattle Soc.	Monthly Bulletin of the Bangalore Dairy Cattle Society.
Mon. Statt. Wholesale Prices Sel. Articles	Monthly Statement of Wholesale Prices of Selected Articles, Calcutta.
Nature, Lond.	Nature, London.
Oil & Soap	Oil and Soap, Chicago.
Onderstepoort J. vet. Sci. & Anim. Industr.	The Onderstepoort Journal of Veterinary Science and Animal Industry, Pretoria, S. Africa.
Pharm. J.	Pharmaceutical Journal and Pharmacist, London.
Philip. Agric.	Philippine Agriculturist, Los Banos.
Philip. J. Sci.	Philippine Journal of Science, Manila.
Proc. Indian Acad. Sci.	Proceedings of the Indian Academy of Sciences Bangalore.
Proc. roy. Soc.	Proceedings of the Royal Society, London.
Proc. U. P. Acad. Sci.	Poceedings of the Academy of Sciences of the United Provinces of Agra and Oudh, Allahabad.
Prof. Pap. Indian Engng., Roorkie	Professional Paper, Indian Engineering, Roorkie.
Prog. Rep. For. Res. India	Progress Report of the Forest Research in India.
Quart. J. geol. Soc. India	Quarterly Journal of the Geological, Mining and Metallurgical Society of India.
Quart. J. Pharm.	Quarterly Journal of Pharmacy and Allied Science (and Pharmacology), London.
Rec. geol. Dep. Mysore	Records of the Geological Department of the State of Mysore.
Rec. geol. Surv. India	Records of the Geological Survey of India.
Bull. econ. Miner.; Prof. Paper	Bulletins of Economic Minerals : Professional Paper.
Rep. Tech. Wk. Bd. Sci. & Industr. Res.	Report on the Technical Work of Board of Scientific and Industrial Research, Delhi.
Return Statist. For. Adm. Br. India.	Annual Return of Statistics relating to Forest Administration in British India.
Sci. & Cult.	Science and Culture, Calcutta.
Sci. Rep. agric. Res. Inst., Pusa.	Scientific Reports of the Agricultural Research Institute, Pusa.
Statist. Yearb. Leag. Nations.	Statistical Yearbook, League of Nations.
Tr. U. K.	Annual Statement of the Trade of the U. K. with British Countries and Foreign Countries, Vol. 3.

SOME ABBREVIATIONS AND SYMBOLS

cal.	Calorie ; calorific.
C. I.	Central India.
conc.	Concentrated ; concentration.
d.	Density.
g.	Gram.
gr.	Grain.
H.	Hardness.
iod. val.	Iodine value.
I. U.	International Unit.
l.	Litre.
md.	Maund (82 lb.).
m. l. d.	Minimum lethal dose.
m. p.	Melting point.
n.	Refractive index
n. a.	Not available.
pH	Hydrogen ion exponent.
Qty.	Quantity.
R	Red.
sap. val.	Saponification value.
unsap.	Unsaponifiable.
W. I.	Western India.
Y	Yellow.
$[\alpha]$	Specific rotation.
ϵ	Refractive index of extraordinary ray.
μg.	Microgram.
ω	Refractive index of ordinary ray.

HIGH LEVEL SILVER FIR (ABIES WEBBIANA)
FOREST AT 11,000', UPPER BASHAHR DIV., PUNJAB

THE WEALTH OF INDIA

RAW MATERIALS

ABELIA R. Br. CAPRIFOLIACEAE

D. E. P., I, 1 ; Fl. Br. Ind., III, 9.

The genus includes 15 species of which only *A. triflora* R. Br. is found in India. It is a large ornamental shrub found in the north-west Himalayas (4,000–10,000′) and is used only for making walking-sticks.

ABIES Mill. PINACEAE

This is a genus of tall evergreen pyramidal trees, commonly called firs. About 24 species are found in the north temperate and arctic regions. The timber of fir is used for the manufacture of boxes and crates. The wood is a valuable source of paper pulp. Some of the species yield turpentine (e.g., *A. alba* Mill.). *A. balsamea* Mill. is the source of Canada balsam.

In India, two species are recognised and are met with at higher altitudes on the Himalayas. The specific distinction between them, according to Troup (III, 1132 ; *vide* also Brandis, 692), is not yet a matter of certainty. *A. pindrow*, a tall tree with a dense narrow conical crown, is the low-level form found in the western Himalayas. *A. webbiana* is the name commonly given to the eastern form as well as to the western high-level form. The former is a tall tree with thick spreading horizontal branches. The latter is very similar to *A. pindrow*, but usually more stunted and gnarled.

A. pindrow Royle Syn. *A. pindrow* Spach
HIMALAYAN SILVER FIR

Fl. Br. Ind., V, 655 ; Troup, III, Figs. 468 and 469.

JAUNSAR—*Morinda* : KASHMIR—*Badar, drewar, tung* ; KUMAON—*Rogha, rao-ragha, rausla* ; KUNAWAR—*Span, krok*.

A. pindrow is a lofty evergreen tree with a dense conical crown of dark green foliage. It grows to a height of 150–200′, and a girth of 8–14′ is ...ion.

This fir is found throughout the western Himalayas from Afghanistan to Nepal, chiefly at 7,500–12,000′ but sometimes descending below 7,000′ in cool ravines. It occurs mixed with spruce (*Picea morinda*) and sometimes with deodar (*Cedrus deodara*), or blue pine (*Pinus excelsa*), etc. Fir forests are found throughout Hazara, Dhaula Dhar in Kangra, and in parts of Kumaon.

The silver fir prefers cool moist situations with deep, rich soil, and is found most commonly on northerly aspects, but on all aspects at higher elevations.

The wood is creamy white, when first exposed, but becomes dull with age. It is very light, straight-grained, and medium-textured. It has no characteristic odour or taste (sp. gr., 0·42 ; air dry wt., 27 lb. per c. ft.)

The wood resembles spruce, and the anatomical structure of the two is very similar, but the fir is distinguished by the absence of normal resin canals, and by the nature of the tracheids in the rays. The growth rings are distinct and show gradual transition from springwood to summerwood. The tracheids are medium-sized, with bordered pits, mostly in one row, on the radial walls, and the tangential pitting is confined to the last few rows of summerwood. The rays are uniseriate, consisting of parenchyma. The ray crossings in the springwood have 2–5 rounded pits, which possess a narrow semiborder and a wide orifice.

It seasons well, but develops long cracks, if care is not taken after conversion. It is not a durable wood and is very prone to fungus and white ant attack. For use in exposed situations, it should be treated with a good preservative, but it is difficult to obtain good penetration without incision. It is fairly soft and is easy to saw and work. As it is knotty, clear timber is difficult to obtain in good lengths.

Fir is a useful light wood, suitable for making packing cases, containers and fruit crates. It is used for planking, for ceiling and floor boards, shingles and water troughs, and also for camp furniture.

Treated silver fir sleepers are being used by the North Western Railway. Trotter (1944, 33) suggests the possibility of its employment in aircraft work. The wood is suitable for paper pulp (Raitt, *Indian For.*, 1918, **44**, 510), but not very good for matches (Ramaswami, 2).

According to Trotter (*loc. cit.*), if the demand develops, it should be possible to obtain at least 30,000 tons annually. Large quantities are available in the Punjab Hills, in Kashmir and in Tehri-Garhwal. Trees having a girth of 8–10′ are best for the extraction of big timber (Gamble, 720). At present, it is chiefly extracted in the sleeper form. The price is about 12 As. per c. ft. and Rs. 2–3 for broad gauge sleepers.

Simonsen (*Indian For. Rec.*, 1922, **8**, 368) obtained from the leaves of *A. pindrow*, 2·5% of essential oil with a strong odour of turpentine (sp. gr., 30°/30°, 0·8558; *n*, 1·4667; sap. val., 5·3; sap. val. after acetylation, 15·4; acid val., 0·3). The oil was found to contain over 70% of α- and β-pinene. The oil is of no commercial value as turpentine, because of its high cost and the difficulty in procuring it in large quantities.

A. webbiana Lindl.=*A. spectabilis* (D. Don) Spach EAST HIMALAYAN SILVER FIR

D. E. P., I, 4; Fl. Br. Ind., V, 694; Troup, III, Fig. 473; Pl. II.

NEPAL—*Gobra salla*; BHUTIA—*Dumshing*.

A tall evergreen tree, with thick spreading, horizontal branches, attaining a height of 200′. It is found in Sikkim and Bhutan at 9,000–13,000′. Above 10,500′, it often forms large areas of pure forests.

The wood of *A. webbiana* is similar to that of *A. pindrow* and is used for the same purposes. It is reported to be suitable for the manufacture of cheaper grades of pencils (Rehman & Ishaq, *Indian For. Leafl.*, No. 66, 1945, 5).

The dried leaves are regarded as carminative, and are used in northern India as *talispatra*. The leaves are considered useful in cases of cough, phthisis, etc. A purple or violet dye is said to be extracted from the cones. The tree is said to yield a white resin (Kanny Lall Dey, 1).

ABROMA Jacq. STERCULIACEAE

A small genus of 10 species, distributed in tropical Asia and Australia. The bark of *A. augusta* yields good fibre.

A. augusta Linn. PERENNIAL INDIAN HEMP, DEVIL'S COTTON

D. E. P., I, 8; C. P., 1; Fl. Br. Ind., I, 375; Kirt. & Basu, Pl. 153.

HIND. & BENG.—*Ulatkambal*.

A large spreading bush with fibrous bark and irritant hairs. It occurs wild or cultivated in U. P., Sikkim (3,000′), Khasia Hills (4,000′) and Assam.

The fibre is readily separated by retting the bark in water for 4–8 days. It is pale yellow in colour, soft and glossy. It makes a pliable and attractive rope which compares favourably with machine-made abaca rope (*Philip. J. Sci.*, 1919, **14**, 581). It resembles jute in chemical behaviour and composition, and has somewhat longer ultimate fibres (*Bull. imp. Inst., Lond.*, 1905, **3**, 258).

The early hopes regarding the commercial utilisation of the fibre have not been fulfilled. The yield per acre is only 100–178 lb., while that of jute runs up to 2,500 lb., and no special use has been found to enhance the value of the fibre (*Bull. imp. Inst., Lond.*, 1939, **37**, 573).

The fresh viscid sap of the root bark is considered to be a valuable emmenagogue and uterine tonic, useful in neuralgic dysmenorrhœa. Chopra and Ghosh (*Indian J. med. Res.*, 1929, **17**, 383) have carried out a preliminary examination of the roots and found traces of an alkaloid (0·01%), and some water-soluble bases (0·1%). These did not exhibit any physiological activity. With cold water, they also obtained a considerable amount of mucilaginous material. Bose (Kirt. & Basu, I, 380) has noted that the active principle of the drug is totally destroyed, if mixed with alcohol or any other preservative. For medicinal purposes, only the fresh or dried root bark should be used.

Chopra (262) states that Sirkar found fairly large quantities of magnesium salts in an aqueous alcoholic extract of the plant, and that these might be responsible for its efficacy in uterine hæmorrhages.

ABRUS Adans. LEGUMINOSAE

The genus comprises 6 species of shrubby twiners, distributed throughout the tropics. Two of the species occurring in India are medicinal.

A. precatorius Linn. INDIAN LIQUORICE, JEQUIRITY

D. E. P., I, 10; Fl. Br. Ind., II, 175; Pl. III, 1.

SANS.—*Gunja*; ARAB.—*Ainuddik*; PERS.—*Chashmekharos*; HIND.—*Ghungchi, rati*; BENG.—*Kunch*; MAR.—*Gunja*; GUJ.—*Chanoti*; TEL.—*Guriginja*; TAM.—*Gundumani*; KAN.—*Gulaganji*; MAL.—*Kunni*.

A beautiful climbing shrub with paripinnate leaves, sensitive to light and changes in weather. The shiny seeds are of the size of small peas, usually bright scarlet, and with a black eye. Sometimes white seeds, with or without black eyes, are also met with.

It is found throughout India, even at altitudes up to 3,500′ on the outer Himalayas. It is now naturalised in all tropical countries.

The roots and leaves contain glycyrrhizin, the active principle of liquorice, and hence one of its common names. Dongen estimated the amount in the roots at 1·25%, and Hooper is said to have found 10% in the dried leaves (ex Burkill, I, 6). The latter is probably an error. The leaves taste sweet and the roots less so. The decoctions of both are widely used for coughs, colds and colic. When liquorice is not available, the leaves constitute a ready substitute. They are said to be chewed as a remedy for hoarseness.

THE SEEDS *RATI*

The seeds are poisonous and are of special interest. The principal poisonous constituent is abrin, a toxalbumin similar to ricin from castor seeds (Dymock, Warden & Hooper I, 442). Abrin has been resolved into a globulin and an albuminose. Both are poisonous and are inactivated by heat.

In addition to abrin, the seeds contain a fat-splitting enzyme, hæmagglutinin and urease (Wehmer, I, 570). Recently, Ghatak (*J. Indian chem. Soc.*, 1932, **9**, 383) isolated also an alkaloid abrine, $C_{12}H_{14}O_2N_2$ (*vide* also Hoshino, *Liebig's Ann.*, 1935, **520**, 31) a glucoside, abralin, $C_{13}H_{14}O_7$, and a small quantity of fatty oil (6%; sap. val., 192; iod. val., 95). Ghatak has also established that the colouring matter of the seed-coat, abarnin, is a monoglucosidic anthocyanin (*Bull. Acad. Sci., Allahabad*, 1933, **3**, 69).

Chopra has summarised the pharmacology of abrin. It is intensely poisonous, when injected subcutaneously in doses of 0·0005–0·001 mg. per kg. of body weight. An infusion of the bruised seeds, when applied to the conjunctiva may cause fatal poisoning due to absorption of abrin. It is a powerful irritant and produces oedema and ecchymosis at the site of inoculation. It has little or no action on the mouth and throat and is digested and rendered harmless in the stomach.

Abrin in the form of a 5% infusion of the decorticated seeds has been used in cases of granular eyelids and for the relief of pannus. It causes an acute inflammation, which in some cases improves the condition. But it must be regarded as an exceedingly dangerous remedy, as the inflammation is entirely beyond control. In animals, the eye is often completely destroyed. In modern medicine, abrin is no longer used.

The bruised seeds have been used criminally for poisoning cattle, and for homicidal purposes. A paste of the seeds is shaped into the form of spikes or *suis* and hardened by drying them in the sun. These are then used as darts. In human poisoning, a swelling with ecchymosis occurs near the seat of injection, which becomes painful. The swelling increases rapidly and erysipelas supervenes. Death occurs in 3–5 days. Anti-abrin can be produced by repeated, small, and gradually increasing doses, and can be used curatively in abrus poisoning (Modi, 543).

A poultice of the seeds is said to have been used as a suppository to bring about abortion and also instances of its employment by malingerers in the army have been recorded (Minchin, *Indian For.*, 1935, **61**, 776).

From very early times, *rati* seeds have been used as weights by the goldsmiths of India. Each seed weighs about 1·75 grains troy. This practice has spread to Malaya and Java. However, there appears to be no good reason for presuming the invariability of the weights of different seeds.

The seeds are extensively used as beads for necklaces and for other ornamental purposes. The boiled seeds are said to be eaten in Egypt and during famines, in India. If eaten in large quantities, they produce a violent headache.

A. laevigatus E. Mey. (syn. *A. pulchellus* Wall.), a species with flat and linear pods containing 9–12 seeds, is used in Malaya for the same medicinal purposes as *A. precatorius* (Burkill, I, 9).

ABUTILON Mill. MALVACEAE

A large genus of shrubby plants, comprising about 120 species, distributed throughout the tropical and sub-tropical regions. All the species detailed below yield fibre of fair quality, suitable for cordage. *A. theophrastii* is the source of Tientsin jute. *A. polyandrum* Wight & Arn. yields a long silky fibre, resembling hemp. Generally the leaves, roots and stems of these plants contain considerable amounts of mucilage, and hence they

are used as demulcents, emolients and diuretics, and are prescribed in fevers as cooling medicines. Several exotic species of *Abutilon* are grown in gardens for their ornamental flowers.

A. asiaticum G. Don COUNTRY MALLOW

D. E. P., I, 15; Fl. Br. Ind., I, 326.

HIND.—*Kanghi*; BENG. & MAR.—*Mudra*; TEL.—*Tutturabenda*; TAM.—*Tutti*.

A tomentose annual herb chiefly met with in India and Ceylon, along road-sides and river-banks.

The ripe seeds from plants acclimatised in Germany were found to contain fatty oil, 15·5% (sap. val., 193; iod. val., 133), and crude protein, 23·6%. The dried plant gave crude fibre, 23% (*Brit. chem. Abstr., B*, **1938**, 1066).

A. indicum (Linn.) Sweet Syn. *A. indicum* G. Don COUNTRY MALLOW

D. E. P., I, 16; Fl. Br. Ind., I, 327; Pl. III, 2.

SANS.—*Atibala*; HIND.—*Kanghi*; BENG.—*Potari*; TEL.—*Tutturabenda*; TAM.—*Paniyarettutti*; KAN.—*Tutti*; MAL.—*Velluram*.

A hairy under-shrub with golden yellow flowers, abundant throughout the hotter parts of India.

The stems, on retting, yield fibre which resembles that of *A. theophrastii* and is suitable for ropes (Braun, *Der Pflanzer*, 1909, **5**, 10). This is used in a domestic way but does not enter into commerce.

The leaves are rich in mucilage and are used as a demulcent tonic. Heyne (ex Burkill, I, 11) states that in Sumatra a lotion is used warm for rheumatism. In India, an infusion of the roots is taken internally as a cooling medicine. The seeds called *balbij* are rich in mucilage and are laxative and demulcent.

A. theophrastii Medic. Syn. *A. avicennae* Gaertn. INDIAN MALLOW, AMERICAN JUTE

D. E. P., I, 15; C. P., 2; Fl. Br. Ind., I, 328.

A small bush found in north-western India, Sind and Kashmir. It occurs naturally from the Mediterranean to China, and as an introduced plant in the warmer parts of the United States, where it grows wild, as if it were a native plant (Burkill, I, 10).

It is the chief fibre-yielding species and the fibre, called 'China Jute' or 'Tientsin Jute' (*Ch'ing Ma* in Chinese), has long been a commercial product of Manchuria exported from Tientsin. Fifty years ago, extensive attempts were made in North America to produce commercial fibre; and it was said that a yield of 2,240 lb. an acre could be got; but the cultivation failed to prove attractive to the farmers and in many places it has now become a troublesome weed (Burkill, *loc. cit.*).

Regarding cultivation of *A. theophrastii*, see Braun (*loc. cit.*). The plants are ready for cutting in 4–5 months and the fibres are easily separated from the stems by retting them in water for 4–5 days. They can be dyed easily and are much used in China in rug-making. The basts of Indian Mallow cultivated in Manchuria contain: total cellulose, 70·5; and α-cellulose, 50·6 per cent. (*Chem. Abstr.*, 1935, **29**, 7637).

The seeds yield 19% of a semi-drying oil (sap. val., 190·5; iod. val., 123. *Chem. Abstr.*, 1933, **27**, 4915; *vide* also *ib.*, 1930, **24**, 3665).

ACACIA Willd. LEGUMINOSAE

This is a large genus, comprising over 500 species, found in the warmer and drier parts of the world, chiefly in Australia and Africa. Species with pinnately compound leaves are found throughout the tropics, and the phyllodineous ones are natives of Australia. In India, there are about 22 indigenous species, distributed throughout the plains. *A. dealbata*, *A. mollissima*, *A. auriculiformis* A. Cunn. and *A. pycnantha* have been introduced from Australia.

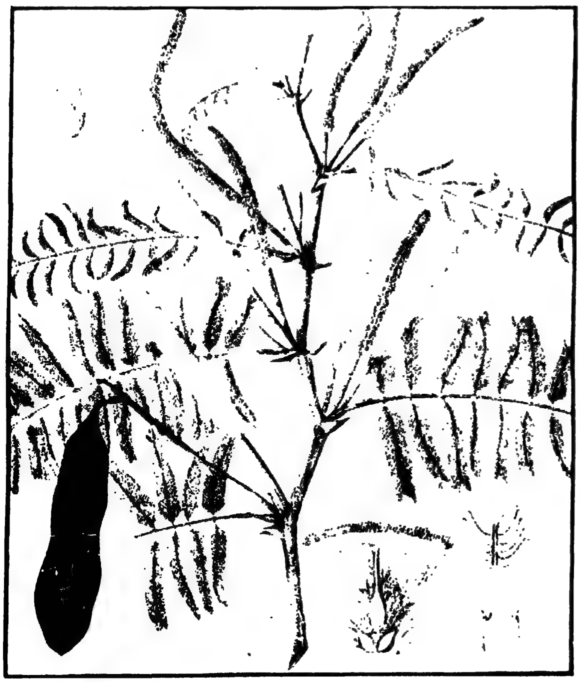
The indigenous species are thorny trees or shrubs and a few are also climbers. They occupy, for the most part, the dry and arid regions, where the forests are often of the nature of open thorny scrub. Some of the acacias are of considerable value for afforestation and reclamation of waste lands. Where conditions are favourable, their growth is rapid and they often develop into large trees.

Indian acacias yield three major products: tannin, gum, and timber.

The tannins are mostly obtained from barks, and *A. arabica* is one of the most important indigenous tanning materials. Among the other tannin yielding species, mention may be made of *A. catechu*, *A. leucophlœa*, *A. pennata*, etc., and the introduced species. The latter are now found on the Nilgiris in south India, where their cultivation is likely to be extended.

1. ABRUS PRECATORIUS

2. ABUTILON INDICUM



3. ACACIA SUMA

4. ACACIA SUNDRA

Most of the acacias furnish valuable gums. True gum arabic is from *A. senegal*, an African species which grows in the dry areas of Sind and Rajputana. The best gum-yielding species in India are *A. arabica* and *A. catechu*. For others, see Caius and Radha (*J. Bombay nat. Hist. Soc.*, 1939, **41**, 261). Indian gum arabic, if properly collected and graded, forms an excellent substitute for the gum of *A. senegal*. Acacia gums find extensive use in medicine and confectionery, and as sizing and finishing materials in the textile industry.

A. arabica is also an important timber yielding species. Others are *A. catechu*, *A. ferruginea*, *A. leucophlœa* and *A. modesta*. The heartwood is generally dark, hard and durable. It is used for a variety of purposes such as agricultural implements, tool-handles, cart-wheels, etc. The acacias also form a valuable source of fuel, and for this purpose, they are grown near villages. The wood of *A. catechu*, on extraction, yields catechu, which finds medicinal and industrial uses.

The pods of *A. concinna* contain saponin. They have long been used in India, especially in the south, for cleansing the body and washing hair. The flowers of some species are very fragrant, and *A. farnesiana* yields the well known Cassie perfume. A peculiar resin covers the foliage of two Australian species, *A. dodonaeifolia* Willd., and *A. verniciflua* A. Cunn. So far, this has not found any use (Burkill, 1, 12).

The pods and leaves of some acacias are used as fodder. The barks of a few are said to be employed for flavouring indigenous spirits. Lac can be grown on several of the species, e.g., *A. arabica* and *A. catechu*.

A. arabica Willd. — BABUL

D. E. P., I, 18 ; C.P., 2 ; Fl. Br. Ind., II, 293 ; Pl. V, 1.

SANS.—*Barburaha* ; ARAB.—*Ummughilan* ; PERS.—*Khare Mughilan* ; HIND., BENG. & MAR.—*Babul* ; PUNJ.—*Kikar* ; GUJ.—*Baval* ; TEL.—*Nallatumma* ; TAM.—*Karuveli* ; KAN.—*Jali, gobli* ; MAL.—*Karuvelam*.

A. arabica is a moderate-sized, spiny evergreen tree. Its bark is dark-brown or black, and longitudinally fissured. The spines are straight and sharp-pointed, and occur in pairs below the petioles. The bright yellow globose flowers (June–Sept.) are sweet-scented, and the pods (3–6″ long and 0·5″ broad) contain 8–12 seeds.

The tree is indigenous to Sind, the Deccan and tropical Africa, and is naturalised in all parts of India. The two most common types of soil on which it occurs are riverain alluvium subject to inundations, and black cotton soil. The largest babul tracts are to be found in Sind (1,70,000 acres). Extensive areas under this tree are also seen in Berar, and on alluvial loam in northern India, and the Punjab. It is not so abundant in the south, and is rare in the extreme north-west on account of its inability to withstand severe frosts. It occurs in Ceylon and has been introduced into the dry zone of Upper Burma.

Babul prefers dry regions, but it will not thrive without irrigation, if the climate is too arid. In areas where it is indigenous, the maximum shade temperature varies from 105–122°F., and the minimum from 30–60°F., and normal rainfall from 3–50 inches.

There are three well recognised varieties :

1. *Telia babul* (also called *Godi* and *Teli*), which is of considerable economic importance, is the typical variety. It is a moderate-sized tree, with a short trunk, a spreading crown, and feathery foliage.

2. Var. *rediana* Cooke, called *Kauria babul*, a smaller tree with a shorter bole and rougher bark. It is found in Berar and Khandesh, and is considered fit only for firewood.

3. Var. *cupressiformis* Stewart, the *Ramakanta* or *Ramkati* babul, is recognised by its broom-like ascending branches. It is found in parts of the Punjab, Sind, Rajputana and the Deccan. In Berar, there is a religious prejudice against its use as *Ramkati* signifies Rama's wand (Troup, II, 420).

The tree varies very much in size. In some places, it is little more than a shrub and in others a fairly large tree, sometimes attaining a height of 50–60′, and a girth of 5–10′. In the Punjab, it attains a girth of $2\frac{1}{2}'$ in 12 years. In Hyderabad (Sind) even after 15 years, its girth is only $1\frac{1}{2}'$. In less favoured localities, it is often only a straggling tree.

Seeds collected from goat and sheep pens are found to be better for artificial sowings than those collected from pods. The moistening and fermentation which they undergo in the alimentary canal of the animals assist germination. Direct

sowing, especially ridge-sowing, has proved successful for afforestation. The seedlings and young plants demand plenty of light, moisture, loose soil, and absence of grass and weeds. Where conditions are favourable, they grow to a height of 5–6′ within a year or two. Thinnings are not carried out in Sind. But in Berar, they are considered essential, and regular thinnings commence at the age of about ten years, and are repeated at intervals of five to six years.

The two most destructive insect pests of babul are the beetles, *Coelasterna scabrata* Fabr., and *Psiloptera fastuosa* Fabr. The former is a dangerous root borer, and the latter strips the bark off the shoots and branches. In Berar, the trees are also attacked by the fungus *Fomes pappianus* Bres., which causes the wood to become brittle. Fortunately, the fungus seems to attack only injured or very old trees.

THE BARK AS TANNING MATERIAL

Babul bark is the most important tanning material of northern India (Edwards, *Indian For. Leafl.*, No. 74, 1945). It is used in village tanneries from the Punjab to Bengal, and very large quantities are consumed by the tanning industry in Cawnpore. It is said that, in 1902, the consumption of bark in Cawnpore was 7,300 tons, reaching a peak of 18,300 tons in 1918. Since then it has somewhat declined, and was about 11,000 tons at the beginning of the last War. As a consequence of the large demand, supplies around Cawnpore have been completely worked out, and bark has now to be imported from such distant places as the Punjab. The price of bark at Cawnpore has also shown a steep rise, from Rs. 1-2-0 per maund in 1920 to Rs. 3-8-0 in 1945. With the expansion of the leather industry during the last War, there was a large demand for bark (22,000 tons in 1940). Shortage of supplies and transport difficulties resulted in its replacement by wattle bark (*vide A. mollissima*) in all the controlled tanneries in the north.

Babul bark is obtained mainly as a by-product, when trees are felled for timber or fuel. It is separated from the logs by beating them with wooden mallets, and the strips thus obtained are dried in the open, chipped into smaller pieces, and sent to the tanneries without any grading. The proportion of bark to wood is roughly 1 : 5 by weight and a plantation of 250 trees per acre, when 15 years old, may be expected to yield some 5 tons of bark. This may be compared with the yield of wattle bark in South Africa, which is about 4 tons per acre in 7–8 years.

The tannin content of the bark varies considerably. Sometimes it is as high as 20%, but the average of bark delivered to the tanneries is about 12%. The bark from older trees, though richer in tannin, is likely to be more coloured. The bark from branches contains 7–12% of tannin. Attempts to obtain a high grade extract have not met with success. The deep colour and the high non-tannin content of the bark are serious disadvantages.

Leather made from babul bark is firm and durable, though harsh and dark coloured. Babul is very good for heavier leathers, but is not suitable for kips, half-tanned hides, like those produced in Madras from *avaram* bark (*Cassia auriculata*). In combination with myrobalans, babul gives a finished leather, which leaves very little to be desired. The Harness and Saddlery Factory at Cawnpore used to employ a mixture of 3 parts of babul and 2 parts of myrobalans for high-class sole and harness leathers. Combinations of babul, myrobalans and wattle bark are being tried for producing fine quality leather.

It is estimated that if babul only were used for the tanning of sole and heavier leather, the annual peace-time requirement would be of the order of 58,300 tons, of which Cawnpore alone would need 38,350 tons (Edwards, *loc. cit.*, 13). Afforestation around tanning centres has not kept pace with depletion, in spite of grave warnings given as early as 1901, and repeated ever since (*vide* also Das, *J. sci. industr. Res.*, 1944, **2**, 200).

In addition to its low tannin content and high colour, babul bark suffers from the disadvantage of lack of organised production and marketing. It is available to the tanning industry only as a by-product, and no attempts seem to have been made to produce a richer or better bark.

The pods contain 12–19% of tannin or 18–27% after the removal of seeds (Imp. Inst., London, Tanning Materials of the British Empire, 1929, 78). The Sudan pods, called *Sant pods* (tannin, 40% in de-seeded pods), are used in local tanneries to produce a pinkish-white leather of good quality. It is said that a babul tree yields about 40 lb. of pod cases in a year and in spite of the large

quantities available, they are rarely used for tanning in India. The chief defect of the pods as tanning material is their tendency to ferment (*vide* Srivastava, *Indian Tr. J.*, 1916, **41**, 206).

The pods are used to some extent by local tanners for drenching or bating, after the liquor has fermented. Their chief use is, when green, as fodder. On dry basis they contain: crude protein, 15·8; ether extract, 0·8; N-free extract, 65·5; fibre 12·4; and total ash, 15·5 per cent. (Sen, *Imp. Coun. Agric. Res., Misc. Bull.*, No. 25, 1946, 18).

BABUL GUM AND GUM ARABIC

The gum exudes from wounds in the bark, mostly during March to May. Though some trees yield a maximum of about 2 lb. of gum a year, the average is only a few ounces. The yield lessens with the increase in age of the trees, and it is said that very old trees do not produce any gum. It is believed that tapping accelerates the flow, but it is not often practised.

Babul gum occurs in the form of rounded or ovoid tears. Each tear is about half an inch in size, and the colour varies from pale yellow to brown or almost black, according to the age of the tree and the conditions of collection. It is completely soluble in water. The darker samples contain tannin and are much less soluble, and leave behind a gelatinous residue.

The gum of *A. arabica*, although called gum arabic, is not true gum arabic which is obtained from *A. senegal*. According to Rangaswami (*Indian J. Pharm.*, 1942, **4**, 130) its moisture content is 13%; on ignition it leaves behind 1·8% of ash (CaO, 52·2; and MgO, 19·7%). The gum is very slightly dextrorotatory, whereas that of *A. senegal* is slightly lævorotatory. It is chiefly composed of galactoaraban, and on hydrolysis, gives *l*-arabinose and *d*-galactose, but no xylose (Wehmer, I, 488).

Babul gum is generally considered inferior to true gum arabic especially for medicinal purposes. Rangaswami (*loc. cit.*) has shown that if proper care is devoted to collection and grading, the gum obtained conforms to the B. P. requirements for acacia gum, except in regard to optical rotation. Further, under similar conditions, its aqueous solutions have higher viscosity, and the gum should therefore prove even more useful as an emulsifying and suspending agent. If proper care is exercised, the marketing of a nearly colourless product should not present much difficulty.

Good quality babul gum is used in calico-printing and dyeing, as a sizing material for silk and cotton, and in the manufacture of paper. Generally it finds application in all other industries, where a mucilage or adhesive is required. It is fried in ghee and used in the preparation of certain sweetmeats, but it is not considered suitable for making European types of confectionery. In pharmacy, it is used as a substitute for true gum arabic and, in indigenous medicine it is credited with numerous virtues. Inferior varieties are employed in the manufacture of matches, inks, distempers and certain types of paints and mortars.

Caius and Radha (*loc. cit.*), have published an enquiry into the trade in gum arabic in Bombay. Three chief varieties are recognised: (*i*) True gum arabic, (*ii*) East Indian gum and (*iii*) Indian gum arabic. Most of the true gum arabic used in India comes directly from Arabia and Africa. The East Indian gum is entirely imported from Aden and other Red Sea ports It is hand-picked and graded in Bombay, and re-exported to Europe and America. Indian gum arabic is the name given to the commodity of Indian origin, consisting of a mixture of babul and other acacia gums.

AVERAGE ANNUAL SEA BORNE TRADE IN GUM ARABIC

(In thousands)

Quinquennium ending	Imports		Re-exports		Exports of Indian merchandise	
	Cwt.	Rs.	Cwt.	Rs.	Cwt.	Rs.
'33-34	6·2	161·9	4·91	65·7	3·8	162·2
'38-39	17·3	352·2	1·6	37·5	0·3	5·5
'43-44	33·1	952·1	4·9	127·3	1·2	35·9

Before the last War, re-exports were mainly to Germany, France and Hong Kong, and during the War, to the United Kingdom.

In India, the collection of gum is entirely in the hands of ignorant people and the crude material, consisting of a mixture of various gums, reaches Bombay from all parts of the country, especially the Deccan, the western and north-western areas. The sale of gum is well organised and most of the wholesale dealers are members of the Bombay Gum Merchants Association, which controls the internal trade.

The crude gum is first broken into small pieces, cleaned and carefully sorted according to size and colour. Two varieties are recognised : gum *bavool* and gum *ghati*. The former consists mostly of acacia gums (from *A. arabica*, *A. catechu*, *A. modesta*, etc.). Occasionally it is found mixed with gums from *Anogeissus latifolia*, *Azadirachta indica* and *Feronia elephantum*, which have similar properties. It is mostly used in printing and dyeing, and is sold at Rs. 32 per cwt. The term gum *ghati* is very confusing and is somewhat indiscriminately used for any mixture of gums, or gums imported from the Western Ghats. Generally, in gum *ghati*, acacia gums are found only to the extent of about 40%. The superior variety is used for edible purposes, and the inferior variety, mainly in whitewashing.

Imported gums are from Sudan, Iran and Iraq. Gums of African origin are gum arabic from *A. senegal*, and another variety called gum *talha* which is probably the same as *tilka* gum derived from *A. seyal* Delile. After arrival, the African gums are carefully sorted, cleaned and graded according to the size and colour of the fragments. The smaller pieces are pulverised and sold as powdered acacia gum. The finer lumps and smaller fragments are sold under the names *maklai* (after the port of Makalla), or *safed gundar*. Three grades are recognised : *maklai* No. 1 and No. 2, and *masuai* (after the port of Massawa) or *lal gundar*, priced at Rs. 38, Rs. 30 and Rs. 26 per cwt., respectively. There is a brisk demand for these, mainly for the preparation of sweetmeats and confectionery as also for adhesive purposes. The gum of *Azadirachta indica* is sometimes found as an adulterant.

Gums from Iran and Iraq, called gum *shiraz* and gum *mamrah* are insoluble gums and have been identified as the products of *Albizzia lebbek* and *Albizzia odoratissima*. They are used in medicine, confectionery, dyeing and printing.

TIMBER

Babul is a strong and tough timber (sp. gr., approx. 0·80; air-dry wt., 51 lb. per c. ft.), and is nearly twice as hard as teak. The sapwood is soft, yellowish white, and usually wide; the heartwood is pale red, generally mottled with darker streaks, and on exposure, turns reddish brown. Anatomically it is characterised by large vessels containing deposits of reddish brown gum and encircled by parenchyma, extensive dense tracts of fine libriform fibres, and conspicuous rays which form a cherry-like fleck on the radial surface (Pearson and Brown, I, 441).

The heartwood is not readily attacked by white ants; but the sapwood decays rapidly and is soon destroyed by insects. If well seasoned, the timber is very durable both in exposed positions and in contact with water. Though the wood is generally used untreated, it is better to treat it when it has to be exposed excessively to wood destroying agencies. The timber seasons well even in the log, and natural air-seasoning gives satisfactory results. Since it is liable to split during the dry season, it should be converted and stacked during or just after the rains. It takes a year to season babul boards up to 2" in thickness. The timber can also be kiln-seasoned without difficulty and it remains unchanged in appearance.

Babul is described as one of the best Indian utility woods, where hardness and toughness are required. It is an easy wood to convert and to saw when green, but when seasoned, it becomes tough. It works well by hand and machines and finishes to a fine surface. It takes a fair polish but requires a good deal of filling. It is a favourite wood for making carts and agricultural implements. It is also used for sugar and oil presses, Persian wheels, tent pegs, boat handles, oars, carving, turnery, etc. It is suitable for hammer handles and is used by the railways for keys, anvils and brake blocks. In Baluchistan, pit props are made out of it.

Babul is usually available in small logs, 5–6' in girth. In some districts, it is also possible to get logs 8–12' in girth. Logs of good quality often fetch Rs. 75 or more per ton of 50 c. ft., but smaller logs are usually sold at Rs. 30–50 per ton. In the United Provinces, babul is sold in small sizes at Rs. 20 per ton, mainly for cart wheel work. Sind, East Khandesh, Poona Division, Central Provinces, United Provinces and Madras are the principal sources of supply (Trotter, 1944, 36).

Babul has a number of minor uses. An extract of the bark, leaves, or pods, is used for dyeing cotton and silk. It gives black, brown or khaki shades, depending on the nature of the metallic salts used for after-treatment (Shroff and Trivedi,

1. ACACIA CATECHU

ACACIA CONCINNA

3. ACACIA FARNESIANA

4. ACACIA LEUCOPHLOEA

Bull. Dep. Industr. & Comm., U. P., New Series, No. 7, 1940, 1). Short lengths of slender twigs are employed in the north for cleaning teeth. The spines are used as fishing hooks and as substitutes for pins.

In some places in Sind, babul serves as a host for the lac insect. It is said to be very valuable for the reclamation of waste lands, especially alkaline soils. It is not a good shade tree, but makes a very good hedge for protecting crops. It is also a very popular fuel and large quantities are consumed annually as firewood (cal. val., moisture-free heartwood, 4946 cals. *Indian For. Bull., New Series*, No. 79, 1932,10).

A. caesia Willd. Syn. *A. intsia* Willd.

D. E. P., I, 50; Fl. Br. Ind., II, 297.

HIND. *Aila*; MAR. *Chilar*; TEL.—*Korinta, koridam*.

A large climber in the sub-Himalayan tract from the Chenab eastwards, ascending to 4,000′ and found throughout India and Burma. The allied species *A. pseudo-intsia* Miq. is found only in the Andamans and Malaya.

According to Gamble (300) the bark is used by the Lepchas in Sikkim as a substitute for soap for washing hair.

A. catechu Willd. CUTCH TREE

D. E. P., I, 27; C. P., 8; Fl. Br. Ind., II, 295; Pl. IV, 1.

SANS. *Khadira*; HIND., BENG. & MAR.—*Khair*; TEL.—*Sandra*; TAM.—*Karangalli*; KAN.—*Kaggali*; BURM.—*Sha*.

A. catechu is a moderate sized tree. In favourable localities, it attains a cylindrical stem up to 5′ in girth with a 20′ bole. Ordinarily it is a small tree with a 2–3′ girth and 8–10′ bole. Its dark greyish brown bark is nearly ½″ in thickness, exfoliating in long narrow strips, brown or red inside.

The tree is widely distributed in India, from the Indus eastwards to Assam and throughout the Peninsula, particularly in the drier regions. It is also common in the dry plains and lower hill forests of Upper and Lower Burma.

Three varieties are recognised by Prain:

Var. *catechu* proper: calyx, petals and rachis covered with spreading hairs. Found in the Punjab, Garhwal, Kumaon and Bihar; also in North Kanara, Ganjam and the Irrawady valley. This is the variety from which *katha* or pale catechu is prepared in northern India.

Var. *catechuoides*: calyx and petals glabrous, rachis puberulous. It is chiefly found in the Sikkim *terai*, Assam, Burma, and to a certain extent, in Mysore and the Nilgiris.

Var. *sundra*: also considered as a separate species (*A. sundra*, q.v.); calyx, petals and rachis all glabrous. Found chiefly in the Indian Peninsula and Upper Burma and is the variety from which cutch is prepared in south India.

KATHA AND CUTCH
(Pl. V, 2.)

The most important product obtained from *A. catechu* is catechu. This is obtained by boiling the heartwood with water. In India, two varieties are marketed *katha* or pale catechu, and cutch or dark catechu. As sold in the bazar, *katha* is found in irregular pieces or small square blocks of greyish colour, which, on breaking, show crystalline fracture. There is a very large internal demand for it for use in *pan* preparations and in medicine. Cutch is marketed in the form of small cubes or blocks, rusty brown or dull orange in colour, and of conchoidal fracture. It is used only for industrial purposes. Although rich in tannin, its use in the preparation of leather has now been replaced to a considerable extent by more suitable materials. However, it is still in demand for use as a dyeing and preserving agent.

In Bombay, a variety of cutch is prepared from the nuts of *Areca catechu*, which is used for similar purposes.

In some of the older trees, a third substance called *kheersal* is met with sometimes in the form of a white powder or crystalline deposit. It is found in the cavities of the wood and occurs in small irregular fragments like bits of pale catechu and is readily purified by crystallisation from hot water. It fetches a high price and is used for medicinal purposes, especially for the treatment of cough and sore throat.

The chief constituents of the heartwood are catechin and catechutannic acid; and catechin content varies from 4–7%. In cutch, the proportion of catechin may be up to 17%.

COMPOSITION OF CUTCH*

(Per cent.)

	Indian 'crystal' cutch	Burma cutch
Moisture	12·5 12·9	13·0 15·9
Tannin (Hide powder method)	57·3–59·1	54·7–60·0
Catechin	14·2–17·2	6·4 11·0
Extractive matter (non-tannin)	24·4–26·5	17·5 26·3
Insoluble matter	3·6–4·2	2·7–9·3
Ash	1·4–1·6	1·9–4·2

* *Bull. imp. inst., Lond.*, 1930, **28**, 433.

The catechin of *A. catechu*, also called acacatechin, is a colourless crystalline material insoluble in cold water but soluble in hot water. It melts at 204-205° and was given the formula $C_{15}H_{14}O_6 . 3H_2O$ by Perkin and Yoshitake (*J. chem. Soc.*, 1902, **81**, 1160). According to Freudenberg and Purmann (ex Nierenstein, 52) acacatechin is not an individual substance but a mixture of four isomerides. However, acacatechin is a comparatively unstable substance and is readily oxidised in solution mainly to catechutannic acid and some brown decomposition products. Catechutannic acid is an amorphous reddish-brown material of unknown constitution. It is readily soluble in water and alcohol, and is insoluble in ether. Purified *kheersal* has been found to melt at 225–230° (Singh, ex Nierenstein, 35), and is one of the isomeric catechins.

EXTRACTION

The extraction of cutch has been carried on from very early times. In certain parts of India, as in Orissa and Gujarat, there are particular communities or castes traditionally engaged in it. The major portion of production is still carried out in small batches by villagers and their methods vary very little from those used centuries ago.

The trees are regarded as suitable when they are 25–30 years old and about a foot in diameter. They vary very much in value as a source of cutch and the yield depends on the size and age of the trees. After felling, the trees are sawn into 2–3′ lengths and the bark and sapwood are removed for use as fuel. The red heartwood is chopped into small pieces about a square inch in size, and boiled with water in earthen pots for about 12 hours. Sometimes the red extract is poured over fresh chips, boiled again, and the process repeated till a decoction of suitable strength is obtained. This is further concentrated in large earthen pots till it attains the consistency of a syrup. It is then poured into wooden frames lined with leaves and allowed to cool. It hardens into a dark brown solid mass, and is cut to suitable sizes and marketed. The efficiency of extraction varies very considerably and the yield may be anywhere from 3–10% by weight of the wood.

This is the general procedure adopted for the extraction of cutch and is followed with local variations, wherever dark cutch is prepared by small manufacturers. In Burma, open iron pans are sometimes used for extraction and concentration. This results in the formation of a very dark product (Rodger, 79).

For the manufacture of *katha*, the concentrated extract is cooled, and set aside for a few days for catechin to separate out. It is then poured into baskets placed over earthen pots or into moulds dug in fine sand. In the former case, the tannins are drained into the pot and crude *katha* is left over in the baskets. In the latter case, sand absorbs all the tannins and *katha* is left over as a crystalline material. *Katha* is not prepared in Burma.

Warth and Leather (*Agric. Ledger*, 1895, **2**, No. 1) and the Forest Research Institute (Trotter, 1940, 256) have shown that considerable economy and improvement in yield can be effected by a few simple modifications of the crude method of preparing cutch. If the heartwood is converted into fine shavings, the proportion of water used for the extraction of wood is reduced from 20 to 10%, or even less, and the extraction is complete in about half an hour. Iron vessels should be scrupulously avoided owing to the action of tannin on iron, resulting in the formation of greenish-brown compounds. It is also necessary to avoid all unnecessary heating to prevent the conversion of catechin to catechutannic acid. The separation of catechin from catechutannic acid is effected by taking advantage of the insolubility of the former in cold water.

In the improved method of small-scale *katha* extraction, the heartwood is finely chipped and boiled with water over an open fire in copper vessels tinned inside. The extract while still hot is then strained into another vessel through fine muslin.

The chips are again boiled with water, and three to five extractions are sufficient to exhaust them. The filtered extract is concentrated till it is of suitable consistency. Concentration should not be carried too far as catechutannic acid retards the crystallisation of catechin in thick solutions. The decoction is allowed to cool slowly and seeded with some crystals of catechin, and let stand for several days. Some times it is necessary to reduce the temperature of the extract by immersing the vessel containing it in cold water. *Katha* crystals separate out and form a layer at the bottom.

The mother liquor is filtered through fine muslin and the catechin collected is washed with some pure cold water to remove all traces of catechutannic acid. The pure material is collected, and, while partially moist, it is moulded into suitable forms, and finally dried. This is very pure *katha*. A second crop of *katha* is obtained when the mother liquor is again concentrated and allowed to cool. This is removed as before. The final mother liquor which is practically devoid of catechin is boiled down and made into cutch in the usual manner.

PRODUCTION AND USES

Messrs. Wood Products Co. Ltd., are the largest producers of *katha* and cutch. In their factory at Izatnagar (Bareilly), wood is chipped by disintegrators and extracted in copper vessels with hot water, under slight pressure. The extract is concentrated in vacuum and cooled in refrigerated tanks for about a week, when *katha* crystallises out. This is separated by filter presses and dried. To obtain cutch, the mother liquor is further concentrated in Kestner evaporators to such a consistency that it solidifies on cooling. The products of this factory are the best available in the market. Their annual production of *katha* is 350 400 tons, and of cutch, 750 800 tons. Most of their cutch is sold to the Government at about Rs. 18 per cwt. and a portion is reserved for shipment to London against Admiralty orders. *Katha* is sold locally at Rs. 120 per cwt. (1944), and there is a growing demand for it in the internal market.

The Bareilly factory has a contract for the supply of 10,000 tons of timber of over 3½′ girth, per annum, from the United Provinces, and the demand for country manufacture is said to be still greater. Production of *katha* in Gwalior is some 400 tons per annum (Bhargava, 34). Orissa Berar and Gujarat are also important centres of production.

In the statistics of the Sea-borne Trade of India cutch and gambier are classed together, and since the latter is not produced to any appreciable extent either in Burma or India imports from Burma and exports from India may be assumed to refer to cutch only. During the quinquennium ending 1941-42, the average annual imports into India from Burma amounted to 43,800 cwt. valued at Rs. 7·40 lakhs. During the same period, India's exports, mainly to the United Kingdom, averaged 3,500 cwt. valued at Rs. 59,000. No *katha* is exported.

Cutch does not hold a high position as a tanning agent as the leather produced is harsh and apt to contain yellow stains. Its chief industrial use is in dyeing cotton and silk, and in calico-printing. Formerly considerable quantities used to be exported to Europe, but it has now been replaced to a large extent by cheaper materials such as mangrove extract. However, there is still a small demand for tanning fishing nets and dyeing sails and mail bags.

According to Ramachandran and Venkataraman (*J. Soc. Dy. Co., Bradford*, 1938, **54**, 513) the use of cutch is mainly restricted to the well-known Catechu Brown or Cutch Brown on cotton and to weighting purposes in silk dyeing. In dyeing cotton, the material is steeped in a boiling solution of cutch to which an addition of copper sulphate has been made. After working in the cooling bath for an hour or more, the material is transferred without washing, but after hydro-extraction if desired, to a second or developing bath containing sodium bichromate. Catechin with copper sulphate gives the same shade as catechutannic acid without this addition, and by the use of copper sulphate in the second case still deeper shades are obtained. Catechu Brown, dyed by the standard method employing copper sulphate and bichromate is reputed to be very fast to light, to acid and alkaline solutions and also to bleaching powder.

At the present day, cutch is probably used to a larger extent in printing than in dyeing. The two main classes of printing in which it finds employment are in producing very fast steam browns and drabs, and in the madder dyed style for producing browns in combination with red, chocolate

and purple. The cutch may be printed on with a starch-tragacanth or British gum thickening, using chromium acetate as mordant and sodium chlorate as oxidising agent.

Catechu may be dyed in admixture with direct dyes, chosen with regard to their ability to withstand the action of copper sulphate and bichromate, the process being cheaper than topping with basic dyes. Basic dyes may be dyed on a catechu bottom; the catechu acts as a mordant, the dye forming with it an insoluble lake, and other mordanting is unnecessary.

Ramachandran and Venkataraman (*loc. cit.*) have suggested the use of cutch for dyeing khaki (Indian Pat., 26980), and have also shown that by coupling cutch with diazo salts a range of bright and attractive shades with moderate fastness to most of the agencies and poor fastness to chlorine could be produced (Indian Pat., 24056).

The use of cutch in the dyeing of ship's sails is said to be based on its excellent fastness and on its preservative action, preventing sea-water from rotting cotton. Cutch dyeings not only exhibit greater fastness to weather conditions than dyeings with coal tar dyes, but they are also less liable to attack by mildew. The treatment of jute for rot-proofing with cutch and potassium dichromate has recently been patented (Lowry, English Pat., 462306).

Puntambaker and Batra (*Indian For. Leafl.*, No. 44, 1943,) have suggested the use of cutch for colouring pulp and paper.

Cutch has long been used in Indian medicine. According to Dymock, Warden & Hooper (I, 557), Sanskrit writers mention two varieties, dark and pale. The latter is *katha*, the medicinal variety. *Katha* is regarded as astringent, cooling and digestive, useful in relaxed conditions of the throat, mouth and gums, also in cough and diarrhoea. Externally it is employed as an astringent and as a cooling application to ulcers, boils and eruptions on the skin. *Katha* also enters into a number of compound preparations and a few prescriptions are given by Birdwood (50).

It is an indispensable ingredient of *pan* preparations. In combination with lime, it gives the characteristic red colouration resulting from the chewing of pan. Continued use is said to cause blackening of teeth.

Catechu, B.P. also called Gambier, is the dried aqueous extract of the leaves and young twigs of the climby shrub *Uncaria gambier* Roxb., a native of Malaya. It is mainly used as an astringent. Cutch or black catechu is included in the B. P. C. as a substitute. It may be distinguished from the former by the fact that it gives no reaction for chlorophyll or for gambier fluorescein. According to the I. P. L., samples of black catechu should not contain more than 25% of water-insoluble residue, or give more than 8% of ash.

The gum from *A. catechu* is said to be of very good quality and is regarded as the best substitute for true gum arabic. It occurs in pale yellow tears and is said to give a thicker and better mucilage than babul gum. The mucilage is not precipitated by neutral lead acetate, but is gelatinised by the basic acetate, ferric chloride and borax. The gum reduces Fehling's solution. It is said that a large proportion of gum arabic sold in south India is really *khair* gum (Trotter, 1940, 285). It is not collected separately and is generally mixed with other acacia gums.

TIMBER

According to Pearson and Brown (I, 146) *A. catechu* is a valuable timber tree of the first class. Sapwood is thick, yellowish white and is not durable. Heartwood is light red, turning brownish red to nearly black with age. A cubic foot of var. *catechu* weighs from 48–64 lb., var. *catechuoides*, 59–75 lb., and var. *sundra*, slightly more (Gamble, 298). It is a hard, tough and durable timber. There are several records of its having lasted for centuries in old temples and it has also done well in harbour works. It is not attacked by white ants or teredo. Generally it is similar to *A. arabica* but is darker in colour and heavier, with abundant chalky deposits in the vessels. Anatomically, it differs from it in having smaller vessels, brown tracts of paratracheal parenchyma, distinct narrow lines of terminal parenchyma and narrower and lower rays. A common characteristic is the presence of white specks of *kheersal* which can be seen with the naked eye.

The timber seasons slowly, but well. Wherever possible, it should be converted green since dry wood is much harder and more difficult to saw. End splitting and cracking are the most common defects, especially in thick planks and

Pl. V

1. A PURE CROP OF BABUL (ACACIA ARABICA)

2. CUTCH BLOCKS AND KATHA PIECES (ACACIA CATECHU)

scantlings. It is therefore advisable to convert it into either 1″ boarding, or scantlings, and to season them for almost a year. Kiln-seasoning does not present any difficulties (Trotter, 1944, 37).

The timber is somewhat difficult to saw and to machine, especially if the wood is old and dry after seasoning. A heavy gauge plate saw with closely spaced teeth and shallow fillets gives the best results and stiff tools are required for machining and turning. It finishes and takes polish extremely well. It is much prized for posts in house construction, and also for making rice pestles, oil and sugar-cane crushers, ploughs, tent pegs and keels and knees of boats. It is eminently suitable as a substitute for beech and box wood, for tools and tool-handles, particularly for mallets and plane bodies. It is excellent for making spokes and hubs of wheels. It is used in the Kolar Gold Fields for side props of shafts and gullies. It is also used as fuel, and furnishes charcoal of very good quality (cal. val. of moisture-free heartwood, 5444 cals. *Indian For. Bull., New Series*, No. 79, 1932, 10).

Plentiful supplies are available in Bengal, Assam, and Burma and generally throughout the Deccan. The chief difficulty, however, is to obtain timber in suitable lengths as it is usually marketed in small sizes required for the *katha* industry. In 1937 it was quoted at Rs. 25–28 per ton in Bengal, at Rs. 40–50 in Orissa, and at Rs. 50–60 per ton in the C. P. (Trotter, *loc. cit.*).

Lac can be successfully grown on *A. catechu*. But it is not used for this purpose to any large extent. Glover (70) describes the use of *khair* as a host tree. It is important to note that *khair* should be infected only in July, as it does not possess sufficient vitality during the late winter and the early summer months to bear a lac crop. If either *palas* (*Butea monosperma*) or *ber* (*Zizyphus jujuba*) brood is employed, the crop is obtained in October or November and is very similar in quality to either pure *palas* or pure *ber* lac. But infection with *kusum* (*Schleichera trijuga*) brood in July gives the best results and the crop is ready in January February. The brood takes on extremely well and the encrustation produced is equal in quality and quantity to that produced on *kusum*. The progeny in turn could be used to infect *kusum*. It is further suggested that this alteration should be practised whenever both *khair* and *kusum* occur together and will result in the production of an extremely healthy resisant type of lac.

A. concinna DC.

D. E. P., I. 44; C.P. 14; Fl. Br. Ind., II. 296; Pl. IV, 2.

HIND.—*Kochi, ritha*; BENG.—*Ban-ritha*; MAR. *Shikakai*; GUJ.—*Chikakai*; TEL. *Shikaya*; TAM. *Shikai*; KAN.—*Sige*; MAL. *Chikaka*.

A common prickly scandent bush. It occurs in tropical jungles throughout India, especially in the Deccan and is also widely distributed in Burma. The pods contain 6–10 seeds and, when dry, appear brown and wrinkled; they are somewhat depressed between the seeds.

The pods of this bush, *shikai*, are extensively used as a detergent and the dry ones are regularly sold in bazaars. In recent years, the powdered pods, sometimes perfumed, are also marketed. *Shikai* is preferred to soap when taking an oil bath as it does not leave the skin dry. Soap nut, which has similar properties, is from *Sapindus* species.

The pods contain saponin (5%). Watt states that they are said to be used in northern Bengal for poisoning fish.

The tender leaves, which are acid, are made use of in chutneys. The bark is used for tanning fishing lines.

A. dealbata Link. SILVER WATTLE

D. E. P., I. 46; C. P., 2; Troup, II, Fig. 174.

A. dealbata is an evergreen tree, native to Tasmania and South Australia. It is now regarded as a variety of *A. decurrens*. It was introduced on the Nilgiris in 1840, where it has become naturalised and is now a characteristic feature of the vegetation from 5000′ upwards. It has also been planted on the Himalayas (Simla, Naini Tal and Almora Hills) chiefly between 6000–8000′. It suffers considerably from snow-break, but regenerates through its numerous root-suckers.

On the Nilgiris, *A. dealbata* reaches a height of over 40′ and attains a girth of over 4′. Its bark is somewhat thinner than that of *A. decurrens* and is silvery grey in appearance. The young shoots and foliage are also of the same colour. It blooms profusely, producing large quantities of yellow flowers. The pods are broader and less constricted between the seeds than those of *A. decurrens*.

The tree has extraordinary powers of reproduction through its spreading root-suckers and is of great value for clothing unstable hill slopes. It serves as an underwood to eucalyptus, and has been found to have a powerful nitrogenising action on the soil (Troup, II, 464).

The bark has only one third the tannin content of that of *A. decurrens*. In South African experts, therefore, it is prohibited to let this bark pass for the true Black Wattle. The tannin content of Nilgiri bark varies from 11-15%, at a moisture content of 10%. However, it could be used along with divi-divi and myrobalans (Choudary, *Dep. Industr. Madras Bull.*, No. 3, 1927, 13).

The gum of *A. dealbata* is the best Australian substitute for gum arabic. Its timber is not of much value and is only used for fuel. The tree is cultivated in the south of France for the sake of its flowers which are highly scented. Mimosae perfume of good quality is obtained from them by extraction with volatile solvents (Poucher, 281).

A. decurrens Willd. GREEN WATTLE

D. E. P., I, 46.

An evergreen tree, reaching a height of 40'. The bark is generally olive green, but is dark grey on older trees. The pale yellow flowers are less plentiful and less scented than those of *A. dealbata*.

The tan-bark yielding species on the Nilgiris was formerly considered to be *A. decurrens*. But it has now been shown to be *A. mollissima* (Edwards, *loc. cit.*; also *vide* Imp. Inst., London, Tanning Materials of the British Empire, 1929, 22).

The bark of *A. decurrens* is also rich in tannin (36-41% at 11% moisture content, Choudary, *loc. cit.*, 12). Plants are now being grown on the Nilgiris from seeds imported from S. Africa.

A. farnesiana Willd. THE CASSIE FLOWER

D. E. P., I, 48; C. P., 14; Fl. Br. Ind., II, 292; Pl. IV, 3.

A thorny bush or small tree reaching a height of 15'. The tree begins to bear flowers from the third year, chiefly from November to March. The fragrant yellow globose flowers are the source of the much valued cassie perfume. A mature tree is said to yield 2 lb. of flowers per season.

The plant is regarded as a native of tropical America and is cosmopolitan in the tropics. It has now spread itself throughout the greater part of India, Burma and Ceylon. It is often cultivated in gardens. In northern India, it sometimes grows gregariously in the loose sandy soil of river beds. In the plains of the Punjab, it grows well on pure sand, in fairly dry places, and would probably do well for checking erosion (Troup, II, 462).

A. farnesiana as well as its variety *cavenia*, are extensively cultivated in and around Cannes (southern France), which has become the centre for the production of the perfume. The perfume is chiefly extracted in the form of a concrete or pomade. The macerated flowers are placed in melted purified natural fat and allowed to stand for several hours. They are then replaced by fresh ones and the process is repeated till the fat is saturated with the perfume. It is then melted, strained and cooled. This constitutes the pomade. The odour is that of violets, but much more intense.

The 'absolute' is prepared by mixing the pomade with alcohol (4-6 lb. in a gallon) and letting it stand for 3-4 weeks at about 25°. The alcohol is then separated and distilled over when the extract is obtained as a fine olive-green liquid strongly smelling of cassie flowers. This is very sensitive to exposure and should be carefully preserved out of contact with air and light. The fatty residue still contains some perfume and is used for making brilliantine, etc. An inferior oil is obtained by the distillation or solvent extraction of flowers.

Poucher (105) mentions that a well known French firm is exploiting a forest of bushes in Syria, near Beirut. The concrete is extracted on the spot and sent to Grasse (S. France) for the production of the absolute. It is said that for some years the perfume was manufactured in India and exported, but the trade was soon lost (Burkill, I, 21).

The ripe pods contain 23% of tannin (Burkill, *loc. cit.*) and the bark is also used for tanning. The tree yields a gum, but this is usually marketed with other acacia gums. The pure gum is not wholly soluble in water, and with 90% water, it gelatinises spontaneously. It is reported to be suitable for confectionery. The leaves are said to be used as a substitute for tamarind in chutneys.

The plant makes a good fence.

A. ferruginea DC.

D. E. P., I, 50; Fl. Br. Ind., II, 295; Beddome, I, Pl. 51.

MAR.—*Pandhra-khair*; GUJ.—*Kaigu*; TEL.—*Ansandra*; TAM. *Velvelam*; KAN. *Banni*.

A medium-sized tree, attaining a height of 12–14 and a girth of 2–3′.

It is found in Gujarat, Berar and the Northern Circars and is moderately common in the Deccan, Konkan, the Carnatic and the eastern slopes of the Western Ghats. It occurs also in the dry forests of Ceylon. The tree is scattered in thorny forests.

The wood is very heavy, straight-grained, and very coarse-textured (sp. gr., 0·98; air-dry wt., 63 lb. per c. ft.). The sapwood is wide and yellowish white. The heartwood is olive-brown, turning darker with age. It is anatomically featured by very large vessels, plugged with reddish brown gum and encircled by a narrow halo of parenchyma, broad conspicuous vessel lines along the grain and narrow rays (Pearson and Brown, I, 450).

With considerable care, it can be seasoned well. The sapwood is perishable, but heartwood is durable even in exposed situations. It saws well and lends itself to turnery, but not so well as *A. arabica*.

The wood is mostly used for cart wheels, posts and beams and for agricultural implements. The bark and the pods possess astringent properties.

The tree also yields a gum similar to gum arabic.

A. jacquemontii Benth.

D. E. P., I, 51; C. P., 14; Fl. Br. Ind., II, 293.

PUNJ.—*Kikar, babul, bamul*; RAJPUTANA—*Bouli, gulli bouli*; GUJ.—*Ratabauli*.

A bushy thorny shrub with sweet-scented yellow flowers, found in the plains of the Punjab, Sind, Rajputana and northern Gujarat and extending to the drier regions of Ceylon. This is one of the gum-yielding acacias. The bark is used in Rajputana as a tan and imparts to leather a brown or black colour. The branches are lopped for fodder.

A. latronum Willd.

D. E. P., I, 51; Fl. Br. Ind., II, 296; Brandis, Fig. 115.

TAM.—*Karodei*; TEL.—*Paki tumma*.

A gregarious thorny shrub similar to *A. planifrons*, but smaller. The trunk rarely grows to 6′.

It is common in the drier parts of the Deccan. It often grows on bare gravelly soil, both on flat ground and on the lower hill slopes, where it may perform a useful function in preventing erosion and in protecting young plants from injury by browsing. It is itself browsed by goats in spite of the formidable protection afforded by its thorns (Troup, II, 461).

The quantity of wood is small, but hard. It forms excellent fuel. It is said to be used for tent pegs.

A. lenticularis Buch. Ham. Syn. *A. lenticularis* Ham.

D. E. P., I, 52; Fl. Br. Ind., II, 296; Brandis, Fig. 117.

KUMAON—*Khin*.

A small tree, found in the sub-Himalayan tract from Kumaon to Sikkim. It is met with also in the drier areas of the peninsula and in Ceylon.

The wood is hard (wt., 68 lb. per c. ft.) and is used for building carts, and for agricultural implements. The timber is said to be attacked by white ants (Haines, 330).

This is also a gum-yielding species.

A. leucophloea Willd.

D. E. P., I, 52; C. P., 15; Fl. Br. Ind., II, 294; Pl. IV, 4.

HIND.—*Safed kikar*; BENG.—*Safed babul*; MAR. *Hewar*; GUJ.—*Haribaval*; TEL.—*Tella tuma*; TAM. *Velvayalam*; KAN. *Bilijali*; MAL.—*Pattacharaya maram*; BURM.—*Tanaung*.

A moderate-sized tree, ordinarily up to 3′ in girth with an 8–10′ bole. It is smaller in very dry localities, and the stem is crooked and gnarled. It has strong, straight, white spines, nearly an inch in length. The bark is light yellowish grey to nearly white and light red inside. It is smooth and exfoliates in irregular scales.

The tree is very characteristic of dry regions. It is found in the plains of the Punjab and throughout the dry forest tracts of the peninsula. It occurs also in the dry zones of Burma.

The wood is moderately heavy, coarse-textured, and the grain is interlocked irregularly (sp. gr.,

0·71; air-dry wt., 45 lb. per c. ft.). The sapwood is yellowish-white and heartwood is brick-red, ageing to reddish brown with darker streaks. Anatomically it is featured by large vessels which are frequently occluded with gum, broad bands of parenchyma alternating with narrow bands of dense fibrous tissue and rather narrow rays (Pearson and Brown, I, 444).

The wood seasons well. It is not very durable, as the sapwood is liable to attack by borers. It is difficult to saw, especially when dry. It does not machine as well as babul, but with care planes to a good surface and takes a good polish.

The timber is strong, hard and tough. It is commonly used for agricultural implements, oil mills, carts and cart wheels, and for turnery. It is everywhere used as fuel (cal. val. of moisture-free heartwood, 4886 cals. *Indian For. Bull., New Series*, No. 79, 1932, 10).

The bark is used for tanning. Hooper (*Agric. Ledger*, 1902, **9**, 26) has found the tannin content to vary with the locality from which the bark is obtained, e.g. Dehra Dun bark, 9%; Mysore bark, 21%. However, it is commercially inferior to *A. arabica* bark. It is also employed as a tan in Java (Burkill, I, 22). The bark yields a fibre when it is steeped in water and beaten. This is used for fishing nets and coarse cordage. It is said to be used in the preparation of spirits from sugar and palm juice. It appears to act as a clarifying and flavouring agent. Hence the tree is also known as *sharab ki kikar*, or distiller's acacia.

The gum is used in indigenous medicine. The young pods and seeds are eaten, and in times of scarcity even the bark is ground and mixed with flour. The pods are generally gathered for fodder.

A. melanoxylon R. Br. AUSTRALIAN BLACKWOOD

D. E. P., I, 53; C. P., 2; Fyson, II, Pl. 93.

This is a large evergreen tree of Tasmania and South Australia. It was introduced on the Nilgiris in 1840 and has become naturalised. The tree has not succeeded anywhere in the north (Parker, 195). In India, it reaches a height of 80′, but rarely a girth of over 5′ and has usually a straight bole. However, it is slowly dying out, partly owing to its susceptibility to the attacks of a *Loranthus*, and partly because it does not coppice well.

The timber is dark brown and beautifully mottled and is much valued in Australia for furniture, railway carriages, etc. On the Nilgiris, it is chiefly used for firewood.

The bark contains 7% of tannin and is of no commercial value (Troup, II, 465).

A. modesta Wall.

D. E. P., I, 53; C. P., 15; Fl. Br. Ind., II, 296; *Indian For.*, 1918, **44**, Pl. 25.

PUNJ.—*Phulai*.

A moderate-sized thorny tree which attains a height of 20–30′ and a girth of 10–12′. The bark is rough, with several irregular cracks.

It occurs more or less gregariously in the sub-Himalayan tract and the outer Himalayas from Jammu westwards, in the Salt Range, and the elevated portions of Sind-Sagar Doab and the lower hills of Hazara.

The wood is very heavy, straight-grained and fine-textured (sp. gr., 0·97; air-dry wt., 62 lb. per c. ft.).

The sapwood is white; the heartwood is russet-coloured, with a greenish cast often with darker streaks. It is anatomically characterised by medium-sized to small vessels occasionally occluded with deposits of light yellowish-brown gum, parenchyma forming a narrow halo about the vessels and narrow rays which form a conspicuous fleck on the radial surface (Pearson and Brown, I, 451).

The wood is strong and extremely hard. It is durable even in exposed situations. The timber is difficult to saw, and does not lend itself well to lathe as the surface is liable to fray.

The timber is often used for cane crushers, Persian wheels, cart wheels and agricultural implements. It is also employed as fuel. The forests have been depleted for firewood and only coppice wood si now available. The larger trees have mostly disappeared except in cultivated lands and around villages (Pearson and Brown, *loc. cit.*).

The tree yields a translucent and pale yellowish gum, but in small quantities. In northern India, this is mostly employed in medicine. In the Punjab, the tender twigs are used for cleaning teeth.

A. mollissima Willd. THE BLACK WATTLE

D. E. P., I, 47 ; C. P., 2.

A. mollissima closely resembles *A. decurrens* in its habit and is sometimes considered to be merely a variety of the latter. The main difference lies in the shape of the leaflets which in *A. mollissima* are short, obtuse, 2-3″ long and closely spaced, while in *A. decurrens* they are narrow, 3-4″ long and widely spaced. The leaves of the former are dark green, whereas those of the latter are yellowish green.

A. mollissima is also a native of southern Australia and Tasmania. It is the principal species grown in S. Africa and is the chief source of the wattle bark of commerce. It was introduced into India, about the year 1840, along with *A. dealbata*, mainly to provide fuel, of which there was then a shortage. It thrives only at elevations of 5,000–7,000′, where there is a well distributed rainfall of about 60 inches per annum. It is now grown on the Nilgiris, the Palnis and in Travancore, but nowhere to any considerable extent. It is also met with on the highlands of Ceylon, but does not appear to be suited to Burma. Some trees are also found in tea estates as wind breaks and shade trees.

A. mollissima is fairly easy to grow. Areas with moderately deep and well-drained soil, protected from severe wind and frost, should be selected. According to Griffith (ex Raghavan, 27) there are about 8,500 acres of land in the reserved forests of the Nilgiri district suitable for its cultivation. Seeds from mature trees retain their germinating power for two years. Germination is slow on account of the hardness of the testa. Hence some pretreatment is necessary. This is generally done by soaking them in boiling water and allowing them to cool in contact with it for about 24 hours. The seeds are then dried and are ready for sowing. Nursery seedlings are planted at an espacement of 6′×6′. They grow rapidly, and at the end of the first year, they are 3–5′ high, when thinning is carried out, leaving 600 plants per acre. At the end of the second year, when the plants are 7–10′ high, another thinning is carried out and the stock is further reduced to 300 per acre and maintained at that figure. Difficulties due to hybridization may be overcome by raising plantations from pure imported seeds.

In South Africa, the bark is expected to be ready for harvesting at the end of 8 years, but in India perhaps the period may have to be extended to 10 years. The net yield per acre is estimated at 4 tons of bark, and 20 tons of timber. Considerable care is necessary in stripping and drying the bark. No portion of the inner surface of the bark should be exposed to the sun, as it leads to discoloration.

WATTLE BARK

Edwards (*Indian For. Leafl.*, No. 76, 1945, 6) gives the average of several recent analyses of Indian black wattle bark : tannin, 35% ; non-tannins, 10% ; colour, R5, Y5. It has nearly the same tanning qualities as the imported bark.

Wattle bark as a tanning material appears to have entered the European market in 1908 and its exceptional merits were immediately recognised by the tanning industry in England and on the Continent. It contains an astringent catechol tannin and lends itself particularly to sole-leather manufacture, but it can also be used very successfully for light leather. Wattle leather is firm and durable.

Although classed as a rapid tanning material, it is stated that the leather is much less red than that obtained from many other catechol tans. The solubility of wattle tannin compares very favourably with that of other commercial vegetable tannins, and the temperature and concentration of extraction are not such important factors as in the case of quebracho (Imp. Inst., London, Tanning Materials of the British Empire, 1929, 6). The tan liquors produce very little acid on fermentation, and in consequence do not plump well. Wattle, therefore makes a good blend with acid producing tanning materials, such as myrobalans (*Terminalia chebula*).

Since its use became extended, there was a rapid increase in demand for the bark and the greatest development of the wattle has taken place in Natal, which has extensive areas eminently suited to its cultivation and a plentiful supply of cheap labour. The area under wattle which in 1908 was 30,000 acres expanded to 223,000 acres in 1921, and to 231,000 acres in 1926. The total exports of wattle bark from South Africa which in 1908, was 24,900 tons increased to 83,600 tons in 1921, valued at £570,100, and in 1926 to 123,400 tons valued at £917,200. The figures for 1921 and 1926 include

the export of extract as well, and for purposes of calculation, 1 ton of extract is taken as equal to $2\frac{1}{2}$ tons of bark. The present value of the industry may be assessed at a conservative estimate, at £2,000,000 a year, of which more than half the money is by the export of bark and extract (Tanning Materials of the British Empire, 9).

WATTLE PRODUCTION IN SOUTH AFRICA IN RECENT YEARS

Year	Bark (Tons)	Price per ton £	Extract (Tons)	Price per ton £
'36 ..	74,165	4 14 10	34,236	12 10 0
'37 ..	68.452	6 4 2	40.864	14 10 0
'38 ..	64,656	7 0 0	29,015	15 14 0
'39 ..	97,955	7 2 0	41,237	14 18 0
'40 ..	72,522	7 10 0	58,662	16 7 5

In South Africa, the cultivation of bark is entirely in private hands and government inspection and grading of bark intended for export was inaugurated in 1913. In East Africa, the industry is further controlled by strict government regulations in order to ensure that bark of good quality only is produced and exported.

Air-dried Natal bark contains usually 10–12% of moisture and is shipped in bags or bales either as stick bark, chopped bark, compressed bark, or shredded or ground bark, and each bale or bag averages 190 lb. net wt. of bark. According to Craib (ex Edwards, *loc. cit.*) trade samples gave tannin, 34–39 (depending on the grade); moisture, 12·5; soluble non-tannins, 10·5–11·5%; and colour, R 3·5–4·5 and Y 6–7 units; and there is an appreciable fall in red as the grade rises.

In 1916, Natal also started the production of wattle bark extract, by leaching and subsequent concentration in evaporators and finally in vacuum pans (*Bull. imp. Inst., Lond.*, 1916, **14**, 599). The extract, now forms an appreciable proportion of the total export of wattle. It is also called mimosa extract, a solid with a guaranteed tannin content of 60%, while it frequently reaches 63%. The red units of colour have been reduced from 3·5 in 1931 to 1·5 in 1941 (ex Edwards, *loc. cit.*) whereas the other qualities remain unchanged relative to bark.

Wattle bark does not seem to have been employed in Indian tanning practice till the year 1915. During the first World War when the demand for hides was at its height, *avaram* (*Cassia auriculata*) and *konan* (*Cassia fistula*) bark became so very expensive or scarce, that an experimental order for wattle was sent to South Africa. Its use was popularised by the Leather Trades Institute and tanners soon learnt how to employ it and further supplies began to flow in. During the slump of 1920-21, imports began to drop, but when trade revived, they increased considerably until 1929, when practically the whole of the hides tanned in south India was either entirely or chiefly wattle-tanned (Guthrie, *Dep. Industr., Madras, Bull.*, No. 40, 1934, 54 & 104).

Its use in the north also has been gradually expanding, owing to the difficulty experienced in obtaining sufficient quantities of babul bark at the tanning centres (*vide A. arabica*). The situation became very acute in recent years owing to the greatly increased war demands, and in Cawnpore and Calcutta all the controlled tanneries had to work with imported wattle bark. As a result of the large expansion of the tanning industry in India, and the advantages in working with wattle to which Indian tanners have now become accustomed, the import from South Africa is not expected to decrease considerably below the 1940 level. The shift, if any, will probably be towards increasing imports of extract, which in 1938 was 182 tons, and in 1940, 1,231 tons.

AVERAGE ANNUAL IMPORTS OF WATTLE BARK

Quinquennium ending	Quantity in tons	Value in lakhs of rupees	Rs. per ton (c.i.f.)
'23-24	1,200	1·18	98
'28-29	7,050	12·11	172
'33-34	11,397	14·30	126
'38-39	16,683	17·94	107·5
'43-44	33,708	47·65	141

Wattle bark is subject to a revenue duty of 3%. The price in the internal market has risen from Rs. 140–154 per ton in 1940 to Rs. 200 per ton in 1944.

In South Africa, it is estimated that of the total receipts, 56% is derived from the sale of the bark and the balance from the timber, which is used for mine props and as fuel. The wood is suitable for destructive distillation. In this respect it compares favourably with European and American hardwoods. The charcoal produced has high calorific value and is fit for domestic use (Sudborough and

Watson, *J. Indian Inst. Sci.*, 1920-21, **3**, 288). Strawboard of fair quality can be produced from the spent bark and wood (*Bull. imp. Inst., Lond.*, 1917, **15**, 496 ; 1919, **17**, 247).

A. pennata Willd.

D. E. P., I, 54 ; C. P., 16 ; Fl. Br. Ind., II, 297.

HIND.—*Aila* ; MAR. *Shembi* ; MAL.—*Kareencha*.

A large, thorny climbing shrub, found throughout India and Burma in situations which are not too dry. It ascends to 5,000′ on the hills.

The bark contains 9% of tannin (Hooper, *Agric. Ledger*, 1902, **9**, 26) and is used in Bombay for tanning fishing nets. It produces stiff leather of somewhat harsh structure and reddish brown colour (*Bull. imp. Inst., Lond.*, 1925, **23**, 159).

A. planifrons Wight & Arn. UMBRELLA THORN

D. E. P., I, 54 ; Fl. Br. Ind., II, 293.

TEL.—*Godugu thumma* ; TAM.—*Kodaivelam*.

A small gregarious tree with flat umbrella-like spreading branches, found in south Deccan (Salem, Madura, Tinnevelly and Travancore) and Ceylon.

The wood is hard and heavy, and is used for agricultural implements. It yields good fuel and for this purpose, it is imported into south India from Ceylon.

Pods are used as fodder for cattle and goats. They are also said to contain tannin.

A. pycnantha Benth. GOLDEN WATTLE

D. E. P., I, 55.

A native of South Australia where, along with *A. mollissima*, it constitutes the chief source of tan bark. It is a smaller tree than the latter and the bark is thinner. It is also said to be a less hardy species and has not found favour in South Africa. Experimental plantations are being raised on the Nilgiris. (Edwards, *loc. cit.*, 3).

The species is very rich in tannin. Analyses have been recorded which show up to 50% of tannin in the air-dried material (Choudary, *loc. cit.*, 12). The best commercial bark has an average of above 38% (Imp. Inst., London, Tanning Materials of the British Empire, 1929, 12). Hooper (*Agric. Ledger*, 1902, **9**, 24) records 34% for a sample obtained from the Nilgiris.

The tree yields Australian gum, which is principally an arabogalactan. An extract of the bark is said to be equal to the best Indian catechu.

A. senegal Willd.

D. E. P., I, 55 ; C. P., 16 ; Fl. Br. Ind., II, 295 ; Brandis, Fig. 116.

SIND *Kher* ; RAJPUTANA- *Kumta*.

A small thorny tree, reaching a height of 10–15′ and a girth of 1–2′. The bark is pale and smooth. The flowers are white and fragrant.

It is found on the dry rocky hills of Sind, in south-east Punjab, in the northern Aravalli hills and other parts of Rajputana. It is abundant in the Sudan, Central Africa and Senegal. It is a hardy species, surviving under most adverse conditions.

This tree yields the true gum arabic, which is an important article of commerce. In India, this gum is mixed with other acacia gums. The gum exudes from cracks in the bark of wild trees. In Africa, it is regularly tapped from trees which are about six years old by making narrow transverse incisions in the bark in February and March. In about a month, tears of gum are formed on the surface and are gathered. The trees are also cultivated over very large areas, as at Kordofan in the Sudan. The gum of wild trees is not a uniform product and is somewhat darker in colour.

After collection, the gum is carefully freed from extraneous matter, sorted, and sometimes ripened in the sun before it is despatched for export. The Senegal gum is somewhat yellowish in colour and some of the tears are also vermiform in shape. It finds its way into the Continental market through the port of St. Louis. Kordofan gum is mainly shipped from Egyptian ports to England and the U.S.A. The 'ripened' or bleached variety occurs in rounded or ovoid tears, over an inch in diameter, and also in broken angular fragments. It has several fine cracks on the surface, which make it opaque. The tears are nearly white or pale yellow in colour and break readily with a glassy fracture. The natural Kordofan gum has fewer cracks and is more transparent. It is yellowish or pinkish in colour, and the tears vary much in size.

The gum is almost odourless and has a bland taste. It is nearly completely soluble in an equal weight of water and gives a translucent, viscous and slightly acid solution. It is insoluble in 90%

alcohol. The aqueous solution, when diluted with water and allowed to stand does not give a gummy deposit. A 10% solution is slightly lævorotatory. A 1% solution does not give a precipitate with neutral lead acetate, and is not coloured by iodine solution. Gum of pharmacopoeial quality should give no re-action with ferric chloride.

It is mostly used in medicine as demulcent and as an emulsifying agent; also for making mucilage (see under *A. arabica*). The substitution of other acacia gums fulfilling the specifications is also permitted. It is also an ingredient of most forms of confectionery of Western make. The common adulterants are artificial gum prepared from starch, and the cheaper varieties of acacia and other gums. Some of the genuine gum is imported into India from Africa and re-exported to Europe and America.

The tree is readily browsed by camels and goats. The heartwood is nearly black and is used for making weaver's shuttles. It is a good fuel.

A. suma Buch.-Ham. Syn. *A. suma* Kurz

D. E. P., I, 60; Fl. Br. Ind., II, 294; Pl. III, 3

BENG.—*Sai-kanta*; MAR.—*Kamtiya*; TEL.—*Tella sundra*; KAN.—*Mugali*.

A medium-sized tree with white bark exfoliating in papery flakes and marked at intervals by horizontal patches of darker colour. It is found in Bengal, Bihar and western Peninsula, and prefers moist localities. The wood is similar to that of *A. catechu*. It is not much used except as fuel. The bark is used as a tan and cutch is said to be prepared from the heartwood.

A. sundra DC.

D. E. P., I, 60; Fl. Br. Ind., II, 295; Pl. III, 4.

MAR.—*Lal khair*; TEL.—*Sandra*; TAM.—*Karangali*; Trade—Red cutch.

This plant was formerly regarded only as a variety of *A. catechu* but it is now considered to be a distinct species. It is a medium-sized tree, 20–25′ high, growing in Coimbatore and the Deccan, north of the river Krishna, common in Kanara, Konkan, Kathiawar, Rajkot, Gujarat and Rajputana. It is found to thrive in dry localities on rocky soil (Chowdhury, *Indian For.*, 1945, **71**, 368).

The wood resembles that of *A. catechu* but is much harder. In anatomical features, it differs from it in having smaller pores, and more abundant gummy deposits in various types of its cells (Chowdhury, *Indian For.*, 1944, **70**, 304).

The wood is used for beams and posts and agricultural implements. Cutch and *katha* are extracted from the heartwood. During the last War, much difficulty was felt in obtaining lignum-vitae (*Guaiacum officinale* Linn.), which is usually used for propeller tail-shaft bearings. The timber of *A. sundra* was found to be a very good substitute as it compares favourably with lignum-vitæ in hardness, crushing strength and other properties. Chowdhury (*loc. cit.*; Foster, *Indian For.*, 1944, **70**, 371) gives the following comparison between the two woods:

	Lignum-vitæ	Red cutch
Sp. gr.	1·17 –1·32	1·01
Air-dry wt. per c. ft.	72–82 lb.	71 lb.
Max. crushing strength per sq. inch	10,480 lb.	14,900 lb.
Hardness, end and side, as compared with teak.	414%	407%

Considerable trade in red cutch is carried on in Bombay under the name 'Red ebony' and the chief source of the wood seems to be Baria state in Gujarat (Chowdhury, *loc. cit.*).

Acacia, False or Locust—see **Robinia pseudacacia**

ACALYPHA Linn. EUPHORBIACEAE

A large genus of herbs and shrubs, comprising some 400 species, found throughout the tropics. Some are cultivated in gardens for their ornamental foliage and catkins. About nine species are found in India, and a few are medicinal.

A. fruticosa Forsk. THE BIRCH-LEAVED ACALYPHA

D. E. P., I, 62; Fl. Br. Ind., V, 415.

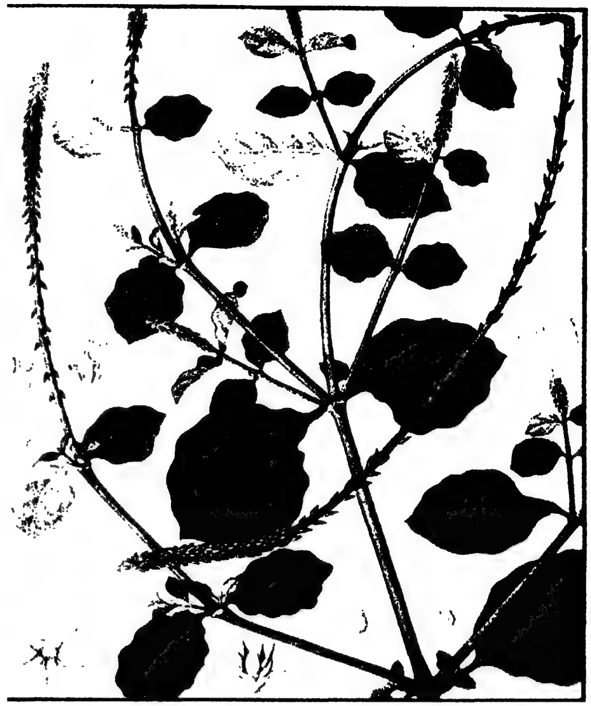
A bushy plant, 4–8′ high, occurring throughout the Deccan peninsula, Ceylon and tropical Burma. An infusion of the leaves is regarded as a stomachic and alterative.

A. indica Linn. INDIAN ACALYPHA

D. E. P., I, 62; Fl. Br. Ind., V, 416; Pl. VI, 1.

SANS.—*Harita-manjari*; HIND. & MAR.—*Kuppi, khokli*; BENG.—*Muktajhuri*; GUJ.—*Dadano*; TEL.—*Kuppichettu*; TAM. & MAL.—*Kuppaimeni*; KAN.—*Kuppi gida*.

1. ACALYPHA INDICA



2. ACHYRANTHES ASPERA

3 ADENANTHERA PAVONINA

A small annual shrub (1–2′ high) occurring as a troublesome weed in gardens and road-sides through-out the plains of India.

According to the B.P.C., the fresh or dry plant is a gastro-intestinal irritant and has been used as a substitute for ipecacuanha. A decoction of the entire plant in doses of ½–1 oz. is used by hakims as a safe and speedy laxative. In cases of constipation in children, the bruised leaves, introduced in the manner of a suppository, invariably give relief. The juice of fresh leaves is a reliable emetic and has been found useful in cases of croup (Kanny Lall Dey, 5).

The leaf of the plant, ground with common salt, quick lime or lime juice is reputed to be a parasiticide and is applied externally. Koman (1919, 13) found that a paste of the leaves with lime juice was beneficial in early cases of ringworm but had no effect in chronic cases. According to Caius and Mhaskar, the plant is quite ineffective as an anthelmintic (*Indian J. med. Res.*, 1923, **11**, 109). *A. paniculata* Miq. is sometimes used as a substitute for *A. indica* (Dymock, Warden & Hooper, III, 291).

Earlier work on the plant indicated the presence of an alkaloid 'acalyphin' (Dymock, Warden & Hooper, III, 293). Rimington and Roets (*Onderstepoort J. vet. Sci. & Anim. Industr.*, 1937, **9**, 193) have found it to contain a cyanogenetic glucoside and triacetonamine, possibly a degradation product of the former. The glucoside crystallises in two forms, thin hexagonal plates (m.p., 182–4°) and fine silky needles (m.p., 108°). The HCN content is 270 mg. per 100 g.

Steyn (*Chem. Abstr.*, 1938, **32**, 8617) found that in addition to HCN the plant contains other substances which cause intense, dark chocolate-brown discoloration of blood, and gastro-intestinal irritation in rabbits.

ACAMPE Lindl. ORCHIDACEAE

D. E. P., I, 64; Fl. Br. Ind., VI, 54.

This is a small genus of epiphytic orchids usually with very long and stout stems. There are about a dozen species, mostly found in India, Malaya, China and Africa. *A. wightiana* Lindl. (=*A. praemorsa* Blatter & McCann) is found throughout Bengal, the western Peninsula and Ceylon. According to Kirt. & Basu (IV, 2411) the plant is a bitter tonic and is used in rheumatism.

ACANTHUS Linn. ACANTHACEAE

D. E. P., I, 66; Fl. Br. Ind., IV, 480.

A small genus of xerophilous plants with thorny leaves including about 25 species found in the Mediterranean region, tropical Africa and eastwards in tropical Asia and Malaysia. *A. ilicifolius* Linn. is an evergreen spinous herb, found in the mangroves of the Indian peninsula, Bengal and Burma. Chopped and bruised, it may be fed to cattle (Paranjpye, *Agric. J. India*, 1920, **15**, 350). In Goa, the leaves are reported to be used for fomentations in rheumatism and neuralgia (Burkill, I, 27).

ACER Lin ACERACEAE

Acer is a large genus (150 species) mostly of trees and a few shrubs, including the wellknown maple, distributed in the north temperate regions. They are commonly found in the eastern parts of North America and east Asia. About 15 species occur in the Himalayas.

The sap of some of the European and American species is sweet. It is regularly tapped and converted into 'maple syrup' and 'maple sugar'. The most important trees which contain this sap are *A. saccharum* Marsh. (Sugar maple), and *A. nigrum* Michx. (Black maple), found in the eastern U.S.A. and Canada. None of the Indian species is known to produce this sap.

A few of the Indian maples, however, yield valuable timber, but they are not utilised to such an extent as in America and Europe.

Some Japanese species have handsome foliage and are grown as ornamental shrubs.

A. caesium Wall.

D. E. P., I, 68; Fl. Br. Ind., I, 695.

PUNJAB—*Trekhan, mandar*; JAUNSAR *Kainju*; KUMAON *Kilu*; KASHMIR *Kinar*; TIBET *Kanshin*.

A tall deciduous tree, reaching a height of 70–80′ and a girth of 12–13′. It is found in the Himalayas from the Indus to Nepal at altitudes of 6,000–9,000′.

The wood is straight grained, very fine-textured and white to pale brownish-white in colour (sp. gr., 0·58; air-dry wt., 37 lb. per c. ft.). It is

anatomically characterised by distinct growth rings (with fine red lines marking the zones), very small pores, and very fine rays, which give the wood an attractive silver grain (Pearson and Brown, I, 301).

The timber can be seasoned well. If left in log, honey-comb cracking develops. It should be converted soon and stacked under cover. The wood is moderately strong and tough to saw. But with care it can be worked to a good finish. It is used for carving, and for making bowls, plates and ladles. It is suitable for furniture, turnery frames, boarding, etc.

A. campbellii Hook. f. & Thoms. HIMALAYAN MAPLE

D. E. P., I, 69 ; Fl. Br. Ind., I, 696.

BENG.—*Kabashi* ; LEPCHA—*Daom, dom, yali, yatli.*

A large deciduous tree, often attaining a height of 100–120′, common in the Sikkim and east Himalayas, at 7,000–10,000′. It plays an important part in afforestation.

The wood resembles that of *A. caesium*, but has larger, less numerous vessels (sp. gr., 0·58 ; air-dry wt., 37 lb. per c. ft.). It is not very strong, but is moderately durable under cover. It saws and machines well. It is extensively used for planking and tea-boxes. Small turnery articles, toys, wooden egg-cups, bread rollers, wooden platters, etc. are made out of it.

A. laevigatum Wall.

D. E. P., I, 70 ; Fl. Br. Ind., I, 693.

NEPAL—*Saslendi, cherauni, thali kabashi* ; LEPCHA—*Tungnyok.*

A handsome deciduous tree found in the Himalayas (5,000–9,000′) and Khasia Hills (5,000′), and in Burma.

The wood is white, shining and close-grained (wt., 43 lb. per c. ft.). It is used for planking and tea-boxes, and is valued locally as a building material.

A. oblongum Wall. HIMALAYAN MAPLE

D. E. P., I, 70 ; Fl. Br. Ind., I, 693.

PUNJAB & JAUNSAR—*Pangoi* ; GARHWAL—*Kirmoli, kirmola* ; KUMAON—*Parpat, petai, patli*; NEPAL—*Mugila, buzimpala.*

A medium-sized evergreen tree of the lower Himalayas, from the Indus eastwards to Bhutan, ascending to 6,000′. It is sometimes planted in gardens as an ornamental tree.

The wood is white in colour, turning pale greyish-brown with age. It is straight-grained and very fine-textured (sp. gr., 0·7 ; air-dry wt., 45 lb. per c. ft.). It is anatomically featured by distinct growth rings, and abundant parenchyma, forming a halo about the pores (Pearson and Brown, I, 299).

The timber seasons well and can be easily kiln-seasoned. It is not durable, if left exposed. It is easy to saw and work, and finishes well, taking a good polish. The wood is used for making ladles, drinking cups, agricultural implements, etc. It is suitable for turnery and minor construction purposes.

A. pictum Thunb. = *A. mono* Maxim.

D. E. P., I, 70 ; Fl. Br. Ind., I, 696 ; Brandis, Fig. 83.

PUNJAB—*Kilpattar, tarkhana, kanjar* ; JAUNSAR—*Kainjli* ; GARHWAL—*Gadkinu, polli, dumitha* ; KUMAON—*Tiktu, pata, bankimu.*

A medium-sized tree, found in the outer and middle Himalayas from the Indus to Assam, ascending from 4,000–9,000′.

The wood is white when freshly cut, turning light pink on drying. It is straight-grained (occasionally curly-grained in the radial plane) and very fine-textured (sp. gr., 0.73 ; air-dry wt., 47 lb. per c. ft.). It is heavier and harder than the wood of *A. caesium* (Pearson and Brown, I, 306). It is commonly used for boards, rafters, plough-shafts, bedsteads, and poles for carrying loads, etc.

The branches are lopped for fodder.

A. thomsonii Miq.

D. E. P., I, 71 ; Fl. Br. Ind. I, 695.

BENG.—*Kabashi.*

A large tree, 100–150′ high, found in Sikkim, Bhutan, Manipur, and the hills of Upper Burma at 4,000–11,000′.

The wood is straight-grained, fine-textured, and greyish white in colour (sp. gr., 0·41 ; air-dry wt., 26 lb. per c. ft.). The wood is soft and light, and

is used for planking. It is suitable for toys, ladles, and similar small articles.

ACHILLEA Linn. COMPOSITAE

A large genus, comprising 115 species of perennial herbs, all natives of the temperate regions of the northern hemisphere. A large number of them are cultivated in gardens for their ornamental foliage. Two medicinal species are found in India.

A. millefolium Linn. MILFOIL, YARROW

D. E. P., I, 78; Fl. Br. Ind., III, 311; Bentley & Trimen, Pl. 153.

PERSIA- *Biranjasif*: AFGHANISTAN– *Buimadaran*; KASHMIR—*Momadnu, chopandiga*.

A perennial herb with corymbose flowers (July–October), common in many parts of the western Himalayas (3,500–12,000′), especially around Simla. It is indigenous to north Asia, Europe and America.

In many parts of Europe, a decoction of the leaves and flower heads is employed as a carminative, tonic and aromatic stimulant. It is seldom used in India (Kanny Lall Dey, 6).

When tested on rabbits, the plant was found to possess weak antipyretic action (Nikonorow, *Chem. Abstr.*, 1941, **35**, 3766).

Milfoil oil is obtained by the distillation of the herb, especially the inflorescence which yields ·049% of oil on dry material. Its odour resembles that of cineole which is one of its constituents (8-10%). The oil is often blue owing to the presence of azulene. The entire herb of American origin with flowers, has been found to give 0·47% of oil (Wehmer, II, 1232).

Older work has indicated the presence of a cyanogenetic glucoside 'achillein', and HCN, 3 7 mg.% (Wehmer, *loc. cit.*)

A. santolina Linn. is a small herb, found in Baluchistan, Afghanistan and Persia, which, because of its powerful odour, repels insects.

ACHRAS Linn. SAPOTACEAE

Achras includes three species, distributed in the West Indies and tropical America. *A. sapota* is indigenous to South America, whence it has been introduced to the moister tropics; it is cultivated all over the world for its edible fruit. The coagulated resinous latex (chicle gum), derived from the bark, is used in the United States for making chewing-gum.

A. zapota Linn. Syn. *A. sapota* Linn. SAPOTA, SAPODILLA

D. E. P., I, 80; Fl. Br. Ind., III, 534: Kirt. & Basu, III, Pl. 579.

An evergreen tree with a spreading crown, attaining a height of 20-30′. Flowers appear throughout the year and the fruits ripen mainly during March, April, August and September. The fruit is a round or oval berry, 2-4″ in diameter. The seeds (9–12) are hard and black, and about ¾″ long.

In India, the plant is grown largely in Bombay, Bengal and Madras, and does better near the coast than in the interior. In Ceylon, it thrives best in the moist areas near the sea. It grows on a wide range of soils, but for vigorous growth, requires a rich or well-manured sandy loam.

Sapota trees are commonly raised by transplantation of nursery-raised seedlings. But seedling trees are slow in growth and in bearing fruits: therefore, layering, budding and grafting are also practised. In Ceylon, layered plants are reported to fruit within two years of planting (Richards, *Trop. Agriculturist*, 1943, **99**, 78). Inarching is the common form of grafting in India.

A caterpillar, *Nephopteryx engraphella* Rag., has been reported to feed on the leaf, flower buds and tender fruits on trees in the Punjab, Bengal, Bihar and Madras (*Madras agric. J.*, 1942, **30**, 409). Spraying with calcium arsenate (½ oz. in 1 gal. of water) is suggested as a remedy.

The fruit is about the size of an egg, with a thin rusty brown skin. The unripe fruit contains an acrid milky juice and some tannin. The flesh in the ripe fruit is yellowish brown, soft and sweet. The fruit pulp contains 14% of sugars (saccharose, 7; dextrose, 3·7 and lævulose, 3·4%) and a bitter principle 'sapotin', 0 13% (Wehmer, II, 936).

The bark contains latex, 20–25% of which consists of a gutta-percha like substance (chicle gum). The tree can be tapped once in three years and yields about 6-8 lb. of gum. Frequent tapping devitalises the plant and consequently tells upon the bearing of fruits (Sperber, *Tropenpflanzer*, 1911, **15**, 220).

The latex is concentrated by boiling till the moisture content is reduced to about 33%, and is allowed to harden in brick-shaped moulds. The solid is white in colour, but becomes red if overcooked. It is slightly aromatic and nearly tasteless. It contains water, 2·2; resins, 44·8; caoutchouc, 17·2; gum, 9·4; sugars, 9·0; starch, 8·2; ash, 0·2% (Wehmer, *loc. cit.*). It is purified by washing with strong alkali, neutralised, and then dried. The final product is an amorphous pale-pink powder, insoluble in water. It forms a very sticky mass when heated. A piece of chewing gum usually contains about 15% of chicle (for details see, *Bull. imp. Inst., Lond.*, 1911, **9**, 147; 1940, **38**, 304; and Hill, 164).

Other uses of chicle are in dental surgery, as substitute for gutta-percha and for making transmission belts. The U.S.A. imports the gum chiefly from Belize in the British Honduras.

The bark contains also 11·8% of tannin (Wehmer, *loc. cit.*, 937), and is used by fishermen of south Luzon for colouring ships' sails and fishing tackles (Villadolix, *Philip. Agric.*, 1932, **21**, 33).

The seed kernels (50% of the total seeds) contain 20% of liquid fat with the following constants: sp. gr. at 31°, 0·8725; n_D/31°, 1·463; sap. val., 205·4; and iod. val., 59·8 (Vidyarthi and Mallaya, *J. Indian chem. Soc.*, 1939, **16**, 443). They also contain 1% of saponin and 0·08% of a bitter principle, 'sapotinin' (Wehmer, *loc. cit.*).

The timber is said to be very durable (Burkill, I, 32).

ACHYRANTHES Linn. AMARANTHACEAE

A small genus of some 15 species of stiff herbs found in tropical and sub-tropical regions. *A. bidentata* Blume is of repute in China, Japan and Java for its medicinal properties.

A. aspera Linn. THE PRICKLY CHAFF FLOWER

D. E. P., I, 81; Fl. Br. Ind., IV, 730; Pl. VI. 2.

SANS.—*Apamarga*; ARAB.—*Atkumah*; PERS.—*Khare-vazhun*; HIND.—*Latjira*; BENG.—*Apang*; MAR.—*Aghadha*; GUJ.—*Aghedo*; TEL.—*Uttaren*; TAM.—*Nayuruvi*; KAN.—*Uttarane*; MAL.—*Katalati*.

A stiff erect herb, 1–3′ high, commonly found as a weed throughout India up to 3000′.

It is much valued in indigenous medicine. The flowering spikes or seeds, ground into a paste, are used as an external application for poisonous insect bites. A decoction of the entire plant is reputed to possess diuretic properties and occasionally it has proved useful in renal dropsies (Kanny Lall Dey, 6; see also Chopra, 562).

The young leaves are served as spinach in the Moluccas (Rump, ex Burkill I, 33).

The ash is rich in potash and it is suggested that the plant might be of value as a cheap green manure (Warden, ex Dymock, Warden & Hooper III, 138).

ACONITUM Linn. RANUNCULACEAE MONKSHOOD

The genus Aconitum comprises 110 species of herbs, distributed over the northern temperate regions of the globe. Some 24 species occur in India, confined to a belt of the alpine and sub-alpine regions of the Himalayas from Kashmir to Nepal, and extending to the hills of Assam and Burma. The tuberous roots of several of the aconites have long enjoyed considerable reputation in medicine and a number of them are now known to contain highly toxic alkaloids.

A. napellus Linn. is official in the B. P. for use as liniment. It is generally prescribed in cases of neuralgia and rheumatism. A tincture of aconite is used internally as a heart and nerve sedative.

A. napellus, however, does not occur in India, and several indigenous poisonous species 'A. ferox' have been in use for similar medicinal purposes under the name *bish* or *vatsnabha*. Internally, *bish* is prescribed in very small quantities usually mixed with a number of other drugs, both mineral and vegetable. The feebly toxic Atis roots (*A. heterophyllum*) are commonly employed as a tonic and febrifuge, and in diarrhoea, dyspepsia, and cough.

The Indian aconites remained for long in a state of botanical confusion until Stapf (Aconites of India, *Ann. R. bot. Gdn., Calcutta*, 1905, **10**) classified them according to their root structure.

1. ATIS ROOTS
(ACONITUM HETEROPHYLLUM)

2. BISH (ACONITUM)

3. ACORUS CALAMUS

4. AEGLE MARMELOS (Bangalore)

5. AEGLE MARMELOS (Delhi)

The following are the alkaloids present in some of the more important medicinal species :

Species	Percentage of ether soluble alkaloids	Chief alkaloid and its percentage	M. l. d. of alkaloids to guinea pigs (mg. per kg. body weight)*
A. napellus	...	Aconitine, 0·4	0·060
A. chasmanthum	4·3	Indaconitine	0·085
A. balfourii	1·2	Pseudaconitine, 0·4	0·045
A. deinorrhizum	0·9	Pseudaconitine, 0·4	0·045
A. ferox (*A. balfourii* & *A. deinorrhizum*)	0·86	Pseudaconitine	0·045
A. spicatum	...	Bikhaconitine, 0·4	...
A. heterophyllum	...	Atisine, 0·4	Feebly toxic

* Chopra, Gupta and Ghosh, *Indian J. med. Res.*, 1928, **15**, 873.

Aconitine first stimulates and then paralyses the sensory nerves. Both internally and externally it depresses the activity of the peripheral terminations of the nervous system. In small doses, the heart is unaffected, but with larger quantities, the force and the rate of the pulse are slowed. It is also a mild diaphoretic.

The pharmacological action of the toxic alkaloids, sometimes classed as 'aconitines' was first studied by Cash and Dunstan (*Proc. roy. Soc.*, 1901, **68**, 379 and *ibid.*, 1905, **B,76**, 468) and found to resemble closely in type, but to differ in degree from that of aconitine. They found pseudaconitine to be the most toxic alkaloid of the group and bikhaconitine and indaconitine more active than aconitine. Indaconitine was later reported to be less active than aconitine (*Bull. imp. Inst., Lond.*, 1906, **4**, 32).

The external and internal uses of aconites are attended with risks. Unless the skin is sound, a dangerous quantity may be absorbed, and its internal use is now restricted since beneficial effects are not produced with any regularity by therapeutic doses (Hale White, 291). Aconitine is one of the most deadly poisons and according to Kobert (ex Henry, 597) a dose of 3 mg. has killed a horse.

In cases of aconite poisoning, the stomach should be washed out by the use of emetics and the patient should be kept warm. Artificial respiration and stimulants (strychnine, atropine, digitalis, etc.) are beneficial.

A combined chemical and biological assay of some of the Indian aconites has been carried out by Chopra *et al.* (*loc. cit.*). The roots of *A. chasmanthum* (10 times) and of A. ferox (2 times) are richer in alkaloids than those of *A. napellus.* The alkaloids of *A. chasmanthum* are less potent (0·7 times) and of A. ferox more potent (1·5 times) than those of *A. napellus. A. chasmanthum* and *A. ferox* may be substituted for *A. napellus. A. ferox* is specially recommended for wider use on account of its more common occurrence, easier identification, and the higher crystallising power of its alkaloid (about 80% being crystallisable).

At present, the entire aconite supply is obtained from wild sources, and the trade is largely confined to the hill tribes of the Himalayas. In order to obtain drugs of standard quality, a more careful collection and cultivation of the medicinal species are necessary.

No reliable figures about the trade in the roots exist. Datta (*Indian J. Pharm.*, 1939, **1**, 84) estimates that from the three main sources of supply viz., (*i*) the north-west Himalayas from Kashmir to Hazara, exporting *A. chasmanthum* and *A. heterophyllum* (mainly to Amritsar), (*ii*) the central Himalayas, exporting *A. deinorrhizum* and *A. balfourii*, (*iii*) and the eastern Himalayas exporting 'Nepal Aconite' (*A. spicatum* and *A. laciniatum*, chiefly to Calcutta, at least 1,000 cwt. of aconites are brought down annually into the plains. Besides consumption within the country, some quantity is also exported from Calcutta and Karachi.

With the exception of *A. heterophyllum* all the well known species have been exported from time to time, and indiscriminately called A. ferox in the foreign market. Indian aconite now imported into England is usually derived from *A. deinorrhizum*. Another variety guaranteed to be from *A. napellus* (*A. chasmanthum* ?) has also been imported since 1938 (Trease, 460).

A. balfourii Stapf

C. P., 22 ; Stapf, *loc. cit.*, 160, Pl. 140.

DARMIYA—*Gobriya* ; WEST NEPAL—*Gobari*.

The plant occurs in the sub-alpine and alpine Himalayas from Gharwal to Nepal, between 12,000–14,000′. Its roots resemble those of *A. deinor-*

rhizum, but are somewhat shorter and thicker with several attached hardened rootlets. Their bitter taste is followed by a tingling sensation.

A. balfourii is a poisonous species and is one of the common constituents of 'A. ferox'. Dunstan and Andrews (*Bull. imp. Inst., Lond.*, 1906, **4**, 32) showed that the roots contained pseudaconitine $C_{36}H_{51}O_{12}N$, m.p., 212–213°, and that the pseudaconitine content of the daughter tubers (1%) was twice that of the mother tubers. Hewey and Sharp (*J. chem. Soc.*, **1928**, 1110) have recently found 1·2% of total alkaloids in the roots, of which pseudaconitine is 0·4%.

Pseudaconitine is highly toxic and biologically 1·5 times as active as aconitine (Chopra *et al., loc. cit.*).

A. chasmanthum Stapf INDIAN NAPELLUS

C. P., 23; Stapf, *loc. cit.*, 142, Pl. 96.

HAZARA—*Mohri*; KASHMIR—*Ban-bal-nag.*

A. chasmanthum occurs in the sub-alpine and alpine zones of the western Himalayas, from Chitral and Hazara to Kashmir, between 7,000–12,000′.

The roots are generally collected late in September. The mother tubers are deeply grooved and wrinkled, black outside and brown right through. The daughter tubers are conic to conic-cylindric, with a broad base (1–1½″), and ½–¾″ thick, bearing numerous root fibres, which leave behind inundated bases when breaking off. When cut, the fracture is cartilaginous, hard and white within the cambium ring, and brownish without. The taste is slightly bitter, followed by a strong tingling sensation. *A. chasmanthum* is very similar to *A. napellus*, for which it was once mistaken. The tubers of the former are, however somewhat smaller, shorter and thicker.

Dunstan *et al.* (*J. chem. Soc.*, 1905, **87**, 1620) isolated indaconitine, $C_{34}H_{47}O_{10}N$, m.p., 202–203°, from the roots of *A. chasmanthum*. Chopra *et al.* (*loc. cit.*) have shown the total alkaloidal content of the roots to be about 4·3%, i. e., about ten times that of *A. napellus*. But the physiological activity of the alkaloids was only 0·7 times that of aconitine.

A. deinorrhizum Stapf

C. P., 22; Stapf, *loc. cit.*, 158, Pl. 103.

BASHAHR—*Mohra*; KASHMIR & PUNJAB—*Dudhia bish* or *safed bikh.*

The plant is met with throughout the central Himalayas from Kunawar to Nepal.

The daughter roots are about 6″ in length and about 1·5″ in diameter at the crown. The surface is dark brown and coarsely wrinkled. The mother tubers are similar, but have longer filiform root-fibres. The drug is very hard and horny, and its starch is gelatinised during drying.

Together with *A. balfourii* it is the principal constituent of A. ferox (*vide A. balfourii*) and is the chief Indian aconite now imported into England.

Psuedaconitine (see *A. balfourii*) was first isolated from the roots of *A. deinorrhizum* by Wright and Luff in 1878. Hewey and Sharp (*loc. cit.*) have found 0·9% of total alkaloids, of which pseudaconitine is 0·4%.

A. ferox Wall.

Stapf, 169, *loc. cit.*, Pl. 109.

A. ferox proper is a rare and poisonous species found in the northern Himalayas of Nepal and Kashmir.

The so-called 'A. ferox' of Indian commerce also known as 'Indian aconite' or *bish* is, in fact, a mixture mainly of *A. deinorrhizum* and *A. balfourii*. Other species occasionally found in the bazaar ferox are *A. spicatum* and *A. laciniatum*.

A. ferox is largely used as an external application. The root is formed into liniment (*lep*) and applied to the skin in cases of neuralgia and muscular rheumatism. Koman (1919, 57, 58 and 1920, 34) has described several indigenous prescriptions of proved utility in fevers, neuralgia, inflammation, gastric disorders and debility. It is also useful as sedative, antipyretic and diaphoretic.

Before use, the Ayurvedic physicians soak the roots in cow's urine or milk (2–3 days) till they become soft. By this treatment the active principles lose their depressant action on the heart and instead become stimulants. Mhaskar and Caius (*J. Bombay nat. Hist. Soc.*, 1937, **39**, 717) have further shown that soaking in cow's milk gives better results than soaking in urine.

A preparation of the roots is much used in all the hilly districts in India as arrow poison.

A. heterophyllum Wall. ATIS ROOT

D. E. P., I, 91 ; C. P., 21 ; Fl. Br. Ind., 29; Stapf, *loc. cit.*, 151, Pl. 100 ; Pl. VII, 1.

SANS.—*Atirisha* ; HIND. *Atis.*

The plant is common in the sub-alpine and alpine zones of the Himalayas, from Indus to Kumaon, occurring at altitudes between 6,000–15,000′. It is extensively imported from the north-west Himalayas into the plains.

The fresh, fully grown root is of ash grey colour about 1–1½″ long, and about ½″ thick at its upper edge. Root of good quality breaks with a short starchy fracture presenting a uniform milky white surface. The taste is purely bitter, and no tingling sensation is produced.

The roots contain the amorphous, non-toxic alkaloid, atisine (0·4%) to which Lawson and Topps (*J. chem., Soc.*, **1937**, 1640) have recently assigned the formula $C_{22}H_{33}O_2N$. Jacobs and Craig (*J. biol. Chem.*, 1937, **143**, 605) have further isolated two crystalline alkaloids, viz., heteratisin $C_{22}H_{33}O_5N$, m.p., 262–267° (decomp.) and hetisin $C_{20}H_{27}O_3N$, m.p., 253–256° (decomp.).

Another non-toxic alkaloid of m.p., 285° has been isolated from *A. palmatum* D. Don which also occurs in India (*Bull. imp. Inst., Lond., loc. cit.*).

Atisine in small doses is much less toxic than the aconites and consequently the species is often regarded as non-poisonous. Its inert character is well known to the hill people who are said to use it as a vegetable.

It is the oldest aconite drug in use in the country. It is prescribed as a valuable febrifuge, a bitter tonic, especially in combating debility after malarial and other fevers. Koman (1918, 4, 11, 16, 18) has recently confirmed its efficiency and recorded several prescriptions for diarrhoea, dysentery and chronic enteritis. The Central Indigenous Drugs Committee in 1901 established its utility as a good bitter tonic, but declared it to be worthless as an antiperiodic.

The drug is chiefly used in the form of pure white bitter powder. It is frequently adulterated with the inspid and inert tubers of *Asparagus sarmentosus* (*satamuli*).

A. laciniatum Stapf

Stapf, *loc. cit.*, 168, Pl. 108.

SIKKIM—*Kalo Bikhoma.*

It occurs in the sub-alpine and alpine Himalayas of Sikkim and adjoining Tibet, between 10,000–14,000′.

The roots are somewhat larger than those of *A. spicatum*. They have numerous circular scars indicating fallen lateral roots.

This poisonous species is found in Nepal Aconite, and also occasionally in A. ferox.

A. spicatum Stapf NEPAL ACONITE

C. P., 21. ; Stapf, *loc. cit.*, 165, Pls. 106 and 107.

NEPAL, SIKKIM—*Bikh* or *Bish.*

This is the most abundant, robust and characteristic species of Nepal and alpine Sikkim and Chumbi, occurring between 10,000–12,000′.

The fresh roots are about 4″ long, soft, flexible and pale-coloured, but when quite dry, they are hard, dark brown or black externally, and brownish red internally. The half-dry root when cut resembles horn, but as it matures and dries, it becomes hard and develops within the tissues dark-coloured, irregular patches.

The roots are sometimes preserved in cow's urine in order to protect them against weevils, but they turn darker externally during storage. The black kind is used for home consumption while the paler one is exported (Datta *loc. cit.*). It is the principal source of the *Bikh* or *Bish* (Pl. VII, 2) of the Calcutta market and is sometimes one of the components of A. ferox.

The poisonous nature of this plant is well known to the people of Sikkim terai, who often muzzle their sheep to prevent them from grazing on it. Dunstan and Andrews (*J. chem. Soc.*, 1905, **87**, 1636) isolated from the roots 0·4% of a new and highly toxic alkaloid named Bikhaconitine $C_{36}H_{51}O_{11}N.\ H_2O$, m.p., 118–123°. The alkaloid differs from aconitine, but resembles pseudaconitine in chemical and physiological properties.

The root appears to have been used more as a poison than as a drug.

A. violaceum Jacq.

Stapf, *loc. cit.*, 144, Pl. 97.

SUTLEJ BASIN—*Tilia Kachang.*

It is met with in the alpine zone of the Himalayas from Gilgit to Kumaon between 10,000–15,000′. The roots are whitish to brown with a pure white

fracture. The taste is slightly sweetish and is not followed by any tingling sensation.

The roots are stated to have been used medicinally and also eaten by the hillmen of Kanawar as a pleasant tonic (Stapf, *loc. cit.*).

ACORUS Linn. ARACEAE

This is a small genus of herbs, comprising 2 species found in the north temperate regions and south-east Asia. *A. gramineus* Soland., a Japanese species, is occasionally met with in Sikkim (up to 6,000′) and the Khasia hills (4,000–5,000′). It is used for the same medicinal purposes as *A. calamus*.

A. calamus Linn. THE SWEET FLAG

D. E. P., I, 99; C. P., 24; Fl. Br. Ind., VI, 555; Pl. VII, 3.

SANS.—*Vacha*; ARAB.—*Vaj*; PERS.—*Agar*; HIND. & BENG.—*Bach*; MAR. & GUJ.—*Vekhand*; TEL.—*Vasa*; TAM.—*Vasambu*; KAN.—*Baje gidu*; MAL.—*Vavambu*.

A semi-aquatic perennial herb with a creeping and much branched aromatic rhizome. The rhizome is cylindrical or slightly compressed, about 0·75-1″ in diameter. Externally it is light brown or pinkish-brown, and is white and spongy within.

It is found wild or cultivated throughout India and Ceylon, ascending to 6,000′ in the Himalayas. The plant thrives in marshy places and moist situations, like the edges of lakes and banks of streams. It is plentiful in the marshy tracts of Kashmir and Sirmoor, in Manipur and the Naga hills.

Clayey loams and light alluvial soils are suitable for its cultivation. The field is irrigated, and ploughed with green manure, before planting. The growing ends or tops of the previous year's crop are planted one foot apart, leaving the leafy portion well above the ground. The crop is ready for harvesting in about a year. The plants are dug out, and the tops are kept for the next plantation. The rhizomes are dried in the sun, before they are marketed. *A. calamus* is regularly cultivated in Koratagere taluk in Mysore. An acre of crop yields about a ton and a half of dry marketable rhizomes (Yegna Narayan Aiyer, 494).

The dry rhizomes contain 1·5–3·5% of a yellow aromatic volatile oil. It has a mellow odour resembling that of patchouli (*Pogostemon cablin*). Kelkar and Rao (*J. Indian Inst. Sci.*, 1934, **17A**, 25) have tabulated the constants for the oil found by different workers and these appear to depend upon the source of the rhizome.

Constants	Indian oil	Commercial oil
d at 15°/15°	1·076	0·958–0·970
n_D/30°	1·5461	1·500–1·508
$[\alpha]_D$	−1·5°	+9° to +35°
Acid val.	2·4	0·3
Sap. val.	4·1	5–20
Sap. val. after acetylation	15·7	30–55
Asarone content	82%	7·08–7·4%

The Indian oil has much higher asarone content than the commercial oil. Kelkar and Rao found that in addition to asarone, $C_{12}H_{16}O_3$ (m.p., 62–63°), it contains small amounts of sesquiterpenes and sesquiterpenes alcohols. The characteristic odour of the oil is ascribed to an unidentified constituent of b.p., 125–135°/ 11 mm. (Qudrat-i-Khuda, Mukerjee and Ghosh, *J. Indian chem. Soc.*, 1939, **16**, 583).

The roots contain also a glucoside named 'acorin' (Wehmer, I, 136).

The dried rhizome is a common bazaar medicine, and is generally used in the form of an infusion. It is an aromatic bitter tonic and carminative. It possesses emetic and anti-spasmodic properties. It produces beneficial results in cases of dyspepsia and chronic diarrhoea.

The powdered rhizome also possesses insecticidal properties and is useful against bed-bugs, moths, lice, etc. (Subramanyan, *Indian J. Ent.*, 1942, **4**, 238).

ACROCARPUS Wight & Arn. LEGUMINOSAE

A genus of trees, comprising three species distributed in India and Malaya.

A. fraxinifolius Wight & Arn.

D. E. P., I, 102; Fl. Br. Ind., II, 292; Beddome, I, Pl. 44.

BENG.—*Mundani*; TAM.—*Malamkonnai*; KAN.—*Hantige, havulagi*; MAL.—*Kurangadi*; BURM.—*Yedama*; TRADE—Mundani.

A lofty deciduous tree, usually with large buttresses at the base. It reaches a height of 100–120′, sometimes 200′, with a clear bole of 150′.

It thrives in areas of heavy rainfall and is found in the evergreen forests of the Western Ghats (4,000′) and in Sikkim (4,000′), Assam, Chittagong and Burma.

The wood is moderately heavy, very coarse-textured, and somewhat interlocked or wavy grained (sp. gr., 0·68; air-dry wt., 43 lb. per c. ft.). The sapwood is white and the heartwood is light red with darker lines. The wood is anatomically characterised by distinct but inconspicuous growth rings, extremely large pores surrounded by a broad sheath of parenchyma or rarely bridged by a narrow strip of it, and fine narrow rays which form a handsome fleck on the radial surface (Pearson and Brown, I, 427).

The timber seasons well, and, if left in log, is liable to split. It is fairly durable, can be sawn and worked with ease to a good finish, and takes on a good polish.

It is used as a box-wood, and for making shingles, boards, planks, and is often substituted for *Calophyllum tomentosum*. It is largely exported from the west coast to Bombay and Karachi (Pearson and Brown, *loc. cit.*)

ACRONYCHIA J. R. & G. Forst. RUTACEAE

This genus of small trees, comprising 20 species is a native of tropical Asia, Australia and the Pacific Islands. *A. baueri* Schott, an Australian species is reported to be good for tool-handles, but the wood of the tropical species is not durable. (Burkill, I, 39).

A. laurifolia Blume

Fl. Br. Ind., I, 498; Talbot, I, Fig. 116.

NEP.—*Paowlay*; ASSAM—*Loajan*; TAM. & MAL.—*Mutta-nari*.

A small tree, rarely 30′ in height, met with in the sub-Himalayan tract from Dehra Dun to Assam up to 4,000′. It is also found on the Western Ghat from North Kanara downwards, and in Ceylon and the Andamans.

The pale yellowish white wood (wt., 47 lb. per c. ft.) is not much used and is said to be aromatic when burnt. It gives good charcoal, which burns clean and is therefore preferred by goldsmiths (Lewis, 77).

The bark and the root are used in external applications for sores and ulcers. The roots are also said to be used in Cochin China as fish poison. The leaves yield an aromatic essential oil (0·06%) and the tender ones are used as condiment (Burkill, *loc. cit.*).

ACROSTICHUM Linn. POLYPODIACEAE

D. E. P., I, 102.

A genus of large ferns with stout erect rhizomes comprising 4 species, found in the warmer parts of the world. *A. aureum* Linn. is a tall, handsome, very tough fern 3–6′ high, found in mangroves and marshy places in India. In Malaya and Borneo, the rhizome is pounded and grated and is applied as a paste to wounds and boils (Burkill, I, 41).

ACTAEA Linn. RANUNCULACEAE

D. E. P., I, 103; Fl. Br. Ind., I, 29.

This genus of erect perennial herbs comprises about 15 species, distributed in the north temperate regions of the world. *A. spicata* Linn. (the Baneberry, Grape-wort) is found in the Himalayas from Bhutan to Hazara. The root is used as a nerve sedative. Tannin has been detected in the seeds (*Chem. Abstr.*, 1929, **23**, 2596), which are also said to yield black, red and green dyes (*ibid*, 1941, **35**, 8300).

ACTINIOPTERIS Link POLYPODIACEAE

A small genus of ferns with fan-like fronds. *A. dichotoma* Bedd. (D. E. P., I, 104) is a small erect, rather stiff fern, 3–7″ high, resembling a miniature fan palm. It is found throughout India and is very common in the Nilgiris up to 2,000′ and in Kumaon. It is said to be used as an anthelmintic and styptic (Dymock, Warden & Hooper, III, 627).

ACTINODAPHNE Nees LAURACEAE

The genus comprises about 50 species of evergreen trees or shrubs, distributed chiefly in the East Indies, Japan and North America. Some are stated to yield valuable timber. Nearly 24 species are found in India.

A. hookeri Meissn.

D. E. P., I, 104; Fl. Br. Ind., V, 149; Beddome, Pl. 296.

MAR.—*Pisa*; URIYA—*Jharchampa*; TAM.—*Thali*; MAL.—*Malavirinya*.

A moderate-sized tree found in the evergreen forests of the Western Ghats, in the Konkan and North Canara. It is commonly met with in Matheran and Mahabaleshwar. It is also found on the east coast in the forests of Orissa.

The seeds contain 48·4% of a solid fat (m.p., 43°–44°; $d^{25°}$, 0·925; $n^{30°}$, 1·449; sap. val., 255·5 and iod. val., Hanus, 10·9) consisting of 96% of trilaurine. The seed shell contains 25% of a reddish brown oil, consisting largely of oleates, mixed with resinates and some trilaurine (Krishna and Puntambekar, *J. Indian chem. Soc.*, 1933, **10**, 395).

The seed kernel of *A. hookeri* is a much better source of lauric acid than palm-kernel oil (*Elaeis guineensis* Jacq.) or coconut oil. Lauric acid is finding several industrial applications, especially for the preparation of sodium laury sulphate, a valuable detergent, in some respects superior to ordinary soap (Puntambekar, *Indian For.*, 1934, **60**, 707).

A cold infusion of the leaves is said to be used in urinary disorders and diabetes.

The leaves contain a very small amount of an amorphous alkaloid. Krishna and Ghose (*J. Indian chem. Soc.*, 1932, **9**, 430; *vide* also *Helv. chim. Acta.*, 1934, **17**, 919), have isolated from the bark an alkaloid, actinodaphnine, $C_{18}H_{17}O_4N$, m.p., 210–11°, which is related to laurotetanine, present in several species of Lauraceae.

Puntambekar (*J. Indian chem. Soc., Industr. & News Edn.*, 1938, **1**, 19) has found in the berries of *A. angustifolia* Nees, an allied species, 37% of fat containing approximately 90% of trilaurine.

ADANSONIO Linn. BOMBACACEAE

A small genus of trees, comprising about 10 species of which some are indigenous to tropical Africa and Madagascar and some are confined to Australia.

A. digitata Linn. THE BAOBAB, MONKEY BREAD TREE

D. E. P., I, 105; Fl. Br. Ind., I, 348.

ARAB.—*Hijid*; HIND.—*Gorak amli*; MAR. & GUJ.—*Gorakh chinch*; TAM.—*Anaipuli*; KAN.—*Magimavu*.

A medium-sized deciduous tree with spreading branches, attaining a girth of 30′ and over. The outer bark is brown, hard and woody; the inner bark, greyish and fibrous. The fruit is indehiscent, woody, 9–12″ long and about 4″ in diameter. It encloses a mealy, slightly bitter pulp in which are embedded hard, shining kidney-shaped seeds.

The tree is a native of tropical Africa and is occasionally cultivated in some parts of U. P., Bihar, Bombay and Madras. In its natural habitat, it is one of the longest lived trees.

The wood is pale yellow in colour, soft and very light. It yields 40–50% of pulp suitable for making paper. As the pulp does not bleach well only brown paper of fair strength can be made from it (*Bull. imp. Inst., Lond.*, 1917, **15**, 326).

Paper of better quality is made from the pulp (33%) obtained from the inner bark. This pulp is dark greyish brown and does not also bleach well. It yields strong and opaque wrapping paper (*Bull. imp. Inst., Lond., loc. cit.*).

The fibre extracted from the inner bark (*Adansonia* fibre) is used by Africans for making ropes and sacking.

The fruit is composed of outer shell (45%), pulp (15%), and seeds (40% approx.). The ash of the outer woody shells is rich in potash (47%) and might serve as manure (Pelly, *J. Soc. chem. Ind., Lond.*, 1913, **32**, 778).

About 50% of the pulp is soluble in water, yielding a mucilaginous liquid and an insoluble residue of cellular tissue. Reducing sugars, acids, proteins, etc. comprise half this amount and the remainder is chiefly made up of pectic substances. An aqueous extract of the pulp possesses an acid taste because of the presence of citric acid (4·4%),

and is used in East Africa for coagulating ceara rubber obtained from *Manihot glaziorii* Muell. – Arg. (Pelly, *loc. cit.*, *vide* also Greene, *Bot. Gaz.*, 1932, **94**, 215).

The seeds have a very tough husk and a soft oily kernel, devoid of starch. They yield about 12% of a fatty oil (sp. gr., 0·915 ; sap. val., 905·1 191·7 and iod. val., 76·7–77·8, Pelly, *loc. cit.*). Pelly suggests that, after softening the hard seed coats by boiling, they may be used as cattle feed. The ash from the seeds is rich in potash (31%) and phosphates (34·2%) and may be used as manure.

The leaves are stated to be used in Africa, as a prophylactic against fevers during the rains and also to check excessive perspiration. The fruit pulp is also employed by the local people, for treatment of fevers and in dysentery (*Bull. imp. Inst., Lond.*, 1906, **4**, 252).

ADENANTHERA Linn. LEGUMINOSAE

A small genus of trees, including about five species found in Asia and Australia. *A. intermedia* Merril (Philippine Islands) and *A. microsperma* Teijsm. & Binn. (Java) yield valuable timber. The bark of *A. intermedia* contains 19–25·5% of tannin, and is used by the Chinese and Javanese tanners (Burkill, I, 45).

A. pavonina Linn. CORAL WOOD, RED WOOD

D. E. P., I, 107 ; C. P., 24 ; Fl. Br. Ind., II, 287; Pl. VI, 3.

SANS.– *Kunchandana* : BENG.– *Rakta kambal* ; MAR.—*Thorligunj* : TAM.—*Anikundumani* ; TEL.—*Bandi gururenda* ; KAN. *Manjetti*: MAL.– *Manjadi*.

A moderate-sized deciduous tree, 60–80′ in height and 7–8′ in girth, with linear narrow pods, 6–8″ long, twisting while opening and exposing the hard, shining scarlet seeds.

It is found in the eastern sub-Himalayan tract, in the Western Ghats, in Burma and in the Andamans. The tree grows well in moist areas and is easily propagated by cuttings. It is often planted along roadsides, especially in southern India. The seeds yield 14% of a fixed oil ($d^{15°}$, 0·9168 ; $n^{60°}$, 1·4570 ; sap. val., 181·4 ; iod. val., 87·9 and acid val., 0·56). Lignoceric acid is present to the extent of 25% in the oil or 2·24% by weight of the seeds (Mudbidri, Ayyar and Watson, *J. Indian Inst., Sci.*, 1928, **11A**, 173). The oil may therefore be used for preparing the acid.

The heartwood is red and is reported to be used as a substitute for true red sandalwood (*Pterocarpus santalinus*). The wood is used in south India for building purposes and for cabinet-making. A paste prepared from the powdered wood is used for applying caste marks.

ADENIA Forsk. PASSIFLORACEAE

D. E. P., V, 254 ; Fl. Br. Ind., II, 603.

A genus of climbing plants with 80 paleotropical species of the old world. *A. palmata* Engl. (syn. *Modecca palmata* Lam.) is a small perennial climbing herb, found in North Kanara and Ceylon. In Ceylon, the juice of leaves and roots are used externally for skin diseases (Macmillan, 371). The root and fruit are said to be poisonous.

ADHATODA Mill. ACANTHACEAE

A genus of shrubby plants, containing about 100 species, confined to the warmer regions of the world. Only two species occur in India.

A. vasica Nees

D. E. P., I, 109 ; C. P., 25 ; Fl. Br. Ind., IV, 540 ; Pl. VIII, 1.

SANS.– *Vasaka* ; PERS.—*Rus* ; HIND.—*Arusha* ; BENG.– *Bakas* ; MAR.– *Adulsa* ; GUJ.– *Aldusa* ; TEL.—*Adasaramu* ; TAM.– *Adadodai* ; KAN.—*Adusoge* ; MAL.– *Atalotakam*.

A small gregarious evergreen shrub, occurring throughout the plains of India, and in sub-Himalayan tracts ascending up to 4,000′.

A. vasica is a well-known drug in the Ayurvedic and Unani systems of medicine, and is recommended for a variety of ailments such as bronchitis, asthma, fever, jaundice and consumption. The leaves and roots are antispasmodic and efficacious in coughs (Central Indigenous Drugs Comm., 1909, 35). According to Krishnaswami and David (*Indian J. Pharm.*, 1940, **2**, 141 ; *vide* also Koman, 1918, 4), the drug is useful as an expectorant and mild bronchial antispasmodic but is of no value in the treatment of tuberculosis.

The leaves contain very small amount of an essential oil, a crystalline acid and a white crystalline alkaloid, vasicine, $C_{11}H_{12}N_2O$, m.p., 190°–191°

(*vide* Sen and Ghosh, *J. Indian chem. Soc.*, 1924-25, **1**, 315). The alkaloidal content of the leaves is 0·2-0·4%, and of the bark it is about 0·35%. The roots contain only traces. Vasicine has also been found to occur in *Peganum harmala* Linn. (Spath & Nikawitz, *Ber. dtsch. chem. Ges.*, 1934, **67**, 45).

The pharmacological action and therapeutic properties of *A. vasica* have been studied by Chopra (*Indian J. med. Res.*, 1925, **13**, 205). These are attributed to vasicine, and the essential oil. The alkaloid produces a slight fall of the blood pressure followed by a rise to the original level, and an increase in the amplitude of heart beats and a slowing of the rhythm. It has a slight, but persistent, broncho-dilator effect. The fluid extract of the leaves relieves cough and bronchial spasms and liquifies sputum. It is a useful remedy in asthma, specially in combination with belladonna. Compound preparations containing *A. vasica* are now available from pharmaceutical manufacturers.

Insecticidal and antiseptic properties are attributed to vasicine. The leaves are said to yield a yellow dye (Wehmer, 1935, 113). They are sometimes used as green manure in paddy cultivation (for analysis of the leaf ash, *vide Sci. Rep. agric. Res. Inst., Pusa*, 1934-35, 117).

ADIANTUM Linn. POLYPODIACEAE

D. E. P., I, 110.

A large genus of ferns, popularly known as Maidenhair comprising nearly 190 species mostly confined to tropical America. They are characterised by slender creeping rhizomes, with black roots and thin triangular-oblong leaves with marginal sori. About 9 species are found in India, chiefly at higher elevations, and they are reported to be medicinal (Caius, *J. Bombay nat. Hist. Soc.*, 1935, **38**, 343). Many are cultivated in gardens and green-houses as ornamental plants.

The American species, *A. capillus-veneris* Linn. (The Maidenhair fern) and *A. pedatum* Linn. (Canadian Maidenhair fern), are also found in India (throughout the moist areas, and on the Himalayas up to 8,000′). These are used as demulcents, expectorants and tonics. *A. caudatum* Linn. and *A. venustum* G. Don (a common Himalayan fern) the common Indian species, are said to possess medicinal properties of a similar nature.

ADINA Salisb. RUBIACEAE

A genus of trees and shrubs, comprising about 15 species, distributed throughout tropical Asia and Africa. Four species occur in India, of which *A. cordifolia* is an important timber tree.

A cordifolia Benth. & Hook. f.

D. E. P., I, 114; Fl. Br. Ind., III, 24; Pl. IX, 1.

HIND.—*Haldu*; BENG.—*Petpuria, dakom*; MAR.—*Heddi*; TEL.—*Pasupu-kadamba*; TAM. & MAL.—*Manja-kadamba*; KAN.—*Arsintega, yettega*; Trade—Haldu.

It is a tall deciduous tree with a large crown and a straight, fluted bole up to 60′ in height. It is found in the sub-Himalayan tracts from Nepal eastwards to Assam extending southwards to the hill forests of Burma. It is common in the deciduous forests of south India, especially in the Eastern Ghats, Mysore and parts of Konkan.

Artificial propagation is not easy. Seedlings raised in seed boxes in April-May may be planted during the following season.

Haldu is a lustrous, yellow or straw-coloured wood with an even texture. It is a light to moderately heavy wood (sp. gr., 0·65; air-dry wt., 40-42 lb. per c. ft.), usually with a straight or interlocked grain. It is anatomically characterised by faint inconspicuous growth rings, small vessels with little paratracheal and abundant metatracheal parenchyma, and long, coarse, tapering fibres in definite radial rows (Pearson and Brown, II, 623; Cox, *Indian For. Bull., New Series*, No. 42, 1921).

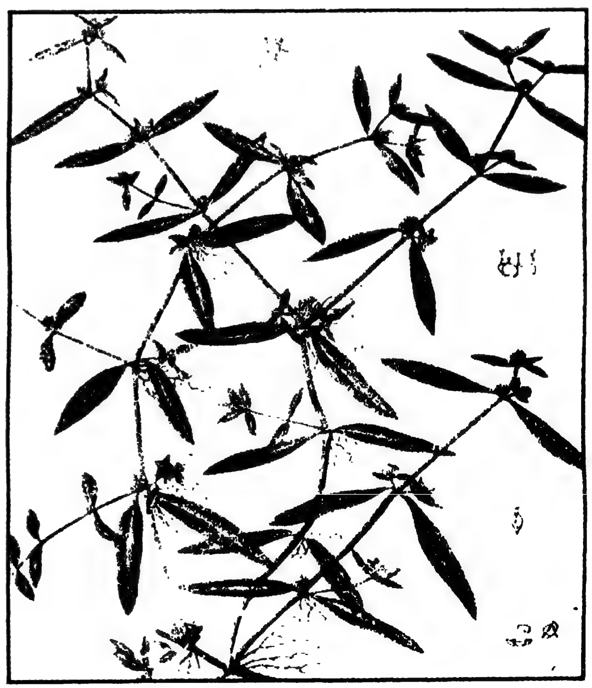
It is a moderately strong, hard wood. It saws easily, takes a good polish and seasons well. It is best to convert green logs and season them under cover for 12 months. The wood is easily amenable to kiln-drying and kiln-seasoning. Haldu is durable under cover but moderately so, in open situations. The wood has a tendency to warp and crack if not properly seasoned, and it is liable to insect attack.

Haldu is largely used for structural work. It is one of the best Indian timbers, suitable for flooring, and for panelling railway carriages. It is the best Indian wood for bobbins, but it is slightly more brittle than European beech (Trotter, 1944, 39). A miscellany of products such as canoes, cigar boxes, toys, combs, agricultural implements,

1. ADHATODA VASICA

AGERATUM CONYZOIDES

3. ALANGIUM SALVIIFOLIUM



4. ALTERNANTHERA SESSILIS

1. ADINA CORDIFOLIA

2. ALBIZZIA LEBBEK

3. ANOGEISSUS LATIFOLIA

and turnery articles are made out of it. The timber is used in making battery separators (Rehman and Ishaq, *Indian For. Leafl.*, No. 14, 1942).

Haldu is available in practically all the provinces. According to Pearson and Brown (*loc. cit.*) the different provinces supply approximately the following quantities (in tons) of timber annually: U. P., 1,500–2,000; Bombay, 2,700; Orissa, 700; Mysore, 600; Madras, 1,000; Assam, 200; Bengal, 150–200; and Burma 1,000.

The price of haldu is unsteady and varies very much (Trotter, *loc. cit.*).

The bark is regarded as febrifuge and antiseptic (Dymock, Wardon & Hooper, II, 171). It contains 7·27–9·7% of tannin (Fraymouth and Pilgrim, ex *Indian For. Bull.*, *New Series*, No. 42, 1921, 5).

From an alcoholic extract of the wood shavings, Lal and Dutt (*J. Indian chem. Soc.*, 1935, **12**, 257) obtained 0·09% of a yellow pigment, adinin C[illegible]$H_{11}O_7$. $3H_2O$, which decomposes at about 200°.

ADONIS Linn. RANUNCULACEAE

A genus of ten species of annual or perennial herbs, occurring chiefly in the temperate regions of southern Europe and western Asia. Some like *A. vernalis* Linn. and *A. aestivalis* are medicinal.

A. aestivalis Linn.

D. E. P., I, 115; Fl. Br. Ind., I, 15.

This erect annual herb (1–2′ high) extends from temperate Europe to Asia. It is a cardiac stimulant and contains 0·216% of a glucoside $C_{25}H_{46}O_{10}$, which resembles adonidin from *A. vernalis*, but is weaker in its physiological action (Wehmer, I, 323).

AEGIALITIS R. Br. PLUMBAGINACEAE

This genus is represented by only one species, *A. rotundifolia* Roxb. (syn. *A. annulata* Kurz, D. E. P., I, 116), found in tropical Asia and Australia. It is an evergreen shrub or small tree, found in the tidal forests of the Sundarbans, Chittagong, Burma and the Andamans. The wood is soft and spongy. The grey bark has been found to contain 11% of tannin (Fraymouth and Pilgrim, ex *Indian For. Leafl.*, No. 72, 1944, 3).

AEGICERAS Gaertn. MYRSINACEAE

A genus of mangrove plants, including 2 species, distributed from Asia to Australia.

A. corniculatum Blanco Syn. *A. majus* Gaertn.

D. E. P., I, 116; Fl. Br. Ind., III, 533; Brandis, Fig. 161.

HIND.—*Halsi*; BENG.—*Khalshi*; MAR.—*Kanjala*; TEL.—*Dudumara*; TAM.—*Narikandam*; BURM.—*Butalet*.

A shrub or small tree, with evergreen leathery foliage and white flowers very common in the mangrove swamps and tidal creeks. It occurs on both sides of the Deccan peninsula, in the Sunderbans, Burma, the Andaman Islands and Ceylon.

The bark is used as a fish poison (Burkill, I, 54). It contains about 7·8% of a saponin $C_{22}H_{30}O_4(OH)_6$, some resin, a caoutchouc-like substance and a crystalline compound, $C_{22}H_{24}O_2$, m.p., 83–84° (Balsac, Maheu, Lefevre and Parveand, *Chem. Abstr.*, 1931, **25**, 230; and Wehmer, II, 925).

In addition to these, the bark (15·3% moisture) contains 6·6% of tannin and 15·9% of water soluble non-tans. It, however, yields leather of poor quality (Balsac *et al.*, *loc. cit.*).

The pericarp of the fruit does not contain any saponin, but the kernel contains a saponin chemically identical with the bark saponin but physiologically ten times more powerful in its action on red blood corpuscles (Weiss, ex *J. chem. Soc.*, 1906, **90**, 571).

The wood is reddish or dark brown, moderately hard and weighs about 40 lb. per c. ft. It is used mostly for building huts and for fuel.

AEGLE Correa RUTACEAE

Aegle includes about three species, distributed in the Indo-Malayan region. *A. marmelos*, found all over India, Burma and Ceylon is an important medicinal tree.

A. marmelos Correa THE BAEL TREE

D. E. P., I, 117; C. P., 26; Fl. Br. Ind., I, 516; Pl. VII, 4 & 5.

SANS.—*Bilva*; ARAB. & PERS.—*Shul*; HIND. BENG. & MAR.—*Bel*; GUJ.—*Bil*; TEL.—*Maredu*; TAM. & MAL.—*Vilvam*; KAN.—*Bilpatre*.

A deciduous tree, 20–25′ in height and 3–4′ in girth, with straight sharp axillary thorns and trifoliate aromatic leaves. The cultivated tree is less spiny. The bark is shallowly furrowed and corky. The greenish-white fragrant flowers appear from May to July and the fruits ripen by December. The fruit is globose (2–4″ in diameter), grey or yellowish, and with a smooth hard aromatic rind. The fruits of cultivated trees are much larger in size. Seeds are numerous, oblong, compressed and with a mucous testa found embedded in a sweet, orange-coloured, thick, mucilaginous pulp.

The tree is found wild in the sub-Himalayan tract, in central and south India and in Burma. It is also cultivated in north India. It thrives in a fairly rich well drained soil. Artificial propagation is usually carried out by transplantation of nursery seedlings. Sometimes plants are raised from root-suckers.

The unripe or half-ripe fruit is regarded as astringent, digestive and stomachic. It is beneficial in cases of diarrhoea and dysentery. The ripe fruit is sweet, aromatic and cooling. It is generally used in the form of a sherbet, or marmalade.

According to Dixit and Dutt (*J. Indian chem. Soc.*, 1932, **9**, 271) marmalosin, $C_{13}H_{12}O_3$, m.p., 103°, a furocoumarin, is the active constituent. This is identical with imperatorin isolated by Späth, Bose, Gruber and Guha (*Ber. dtsch. chem. Ges.*, 1937, **70**, 1021) from *Imperatoria ostruthium* Linn. In doses of 0·05 g. marmalosin acts as a laxative and diuretic. It causes a slight lowering of perspiration and some sleeplessness. In stronger doses, it acts as a cardiac depressant. The fruit contains also 4·6% sugars (Dixit and Dutt, *loc. cit.*) and tannin 9% in the pulp, and 20% in the rind (Wehmer, I, 621). The seeds yield a bitter fatty oil (11·9%) which is taken internally as a purgative in doses of 1·5 g. (Dixit and Dutt, *loc. cit.*).

The root bark, and sometimes the stem bark also is administered in intermittent fevers. In Celebes, the bark is used as a fish poison (Burkill, I, 57). According to Dixit and Dutt (*loc. cit.*) the bark contains umbelliferone and other coumarins, different from marmalosin obtained from the fruits. Their proportion, however, varies with the age of the bark and also the locality from which it is obtained. The bark (from old trees in Bihar) contains also 0·3% of an lakaloid, $C_{13}H_{11}O_3N$, m.p., 142° (Asim Mukerjee, *Curr. Sci.*, 1943, **12**, 209), which was shown by Chakravarty (*J. Indian chem. Soc.*, 1944, **21**, 401) to be identical with fagarine from the leaves of *Zanthoxylum coco* Gill. ex Hook. and Arn. (syn. *Fagara coco* Engl.).

The gummy mucous substance surrounding the seeds, serves as a good adhesive. It is more abundant in young fruits. It is suggested as a varnish for pictures and is said to add brilliancy to water-colour paints. Mixed with lime, it is utilised as a cement and the mixture sets firm rapidly. The dried fruits freed from pulp are used as pill-boxes for keeping medicines, sacred ashes and snuff. Very young fruits are alternated with the seeds of *Elaeocarpus ganitrus* Roxb. (*Rudraksh*) in making necklaces. According to Watt, a yellow dye can be extracted from the rind of the unripe fruit.

The stem yields a good gum occurring in tears like gum arabic. The leaves contain 0·6% of essential oil, mostly composed of d-limonene (Finnemore, 476). They are much used as religious offerings in temples.

The wood is light yellow or yellowish-grey, lustrous and strongly aromatic when first exposed (sp. gr., 0·89; air-dry wt., 57 lb. per c. ft.). The timber is hard, strong and tough, but is not much used. The wood is suitable for making charcoal for producer-gas plants (*Indian For. Leafl.*, No. 35, 1943, 3).

AERVA Forsk. AMARANTHACEAE

D. E. P., I, 124.

A genus of erect, prostrate or climbing herbs or undershrubs, comprising about 15 species, distributed in the warmer parts of Asia and Africa. Nearly 6 species are found in India. *A. lanata* Juss. is an erect or prostrate herbaceous weed, common throughout the hotter parts of India and ascends to 3,000′ on the hills. It also occurs in Ceylon. The plant is said to possess diuretic and demulcent properties.

It is reported to contain some tannin (Chandra, ex *Indian For. Leafl.*, No. 72, 1944, 18).

AESCHYNOMENE Linn. LEGUMINOSEAE

A genus of shrubs or undershrubs, comprising 90 species, distributed in the warmer parts of the world. Two species occur in India.

A. aspera Linn. THE SOLA PITH PLANT

D. E. P., I, 125; C. P., 29; Fl. Br. Ind., II, 152.

HIND.—*Sola*; BENG.—*Shola*; TEL.—*Nir jiluga*; TAM.—*Attu neddi*; KAN.—*Bendu*.

A little-branched stout herb with spongy floating stem, growing to a height of 6–10′. The stem attains a diameter of about 2″.

It is plentiful in Bengal and Assam and is also found in south India and Burma. It is usually met with in marshy places, waterlogged situations, and on the margins of tanks or lakes.

The stem consists of a mass of very light, soft pith which has very good insulating properties. It is used extensively in making sun hats (sola topis). The thicker portions of the stem are cut into lengths of 2–3′ and are tied into bundles and dried. After removing the bark, the pith is split into thin sheets. The hats are worked on wooden or clay moulds and the sola sheets are wound round in layers. The best quality of pith comes from Bengal, and Calcutta is the centre of trade.

The pith is also used for making toys, artificial flowers, models, etc. It may also be used as a substitute for bottle-corks and in the manufacture of swimming jackets and life-belts.

A. indica Linn.

D. E. P., I, 126; C. P., 29; Fl. Br. Ind., II, 151.

BENG.—*Kath shola*; ASSAM—*Kuhila*; TEL.—*Tiga jiluga*; TAM.—*Nellithalli*.

A very slender much branched annual, found in Bengal, Assam, south India and Burma. It is common in wet grasslands.

The pith of this plant is of inferior quality. It is harder than that obtained from *A. aspera* and cannot be split into thin sheets. However, it is also used for sola topis, with a surface dressing of sola pith.

AESCULUS Linn. SAPINDACEAE

A genus, including about 25 species of trees and shrubs, distributed in the temperate regions of Asia, Europe and America. Two species are found in India, *A. indica*, and *A. punduana* Wall. (=*A. assamica* Griff.). The former is a second class timber tree.

A. hippocastanum Linn., the Horse-chestnut tree, indigenous to Asia Minor and Greece, is occasionally met with in northern India as an ornamental tree.

A. indica Colebr. INDIAN HORSE CHESTNUT

D. E. P., I, 126; Fl. Br. Ind., I, 675.

HIND.—*Pangar, bankhor*; N. W. F. P.—*Torjaga*; SUTLEJ—*Kanur*; RAVI—*Gun*; KASHMIR—*Hane, hanudun*

A large deciduous tree (height, 100′; girth up to 10′) with a short, straight, cylindrical bole and a spreading crown with drooping branches. It is distributed from the Indus to Nepal, generally growing gregarious in rich, moist, shady ravines on the hill tops of Kashmir, the Punjab and the U.P., at an altitude of 4,000–10,000′.

The wood is white or pale pinkish-white, when freshly cut, but becomes pinkish-brown on exposure. It is light (sp. gr., 0·54; air-dry wt., 35 lb. per c. ft.), moderately soft and even-textured, generally with a straight or narrowly interlocked grain. Anatomically it is characterised by sharply defined growth rings, narrow medullary rays, very small vessels and fine non-libriform fibres (Pearson and Brown, I, 289).

The wood is not durable in open situations, but is fairly so under cover. It is easy to saw, finishes to good surface and takes a good polish. The timber seasons well without much degrade. Green conversion and subsequent kiln-seasoning are recommended (Pearson and Brown, *loc. cit.*).

It is largely used for buildings, packing cases, water troughs, cooperage, and fittings for boats. Selected pieces of the timber are useful for panelling in railway carriages.

Though the tree is common in many parts of Kashmir, the Punjab and the U.P., it is not worked out to any large extent because of the difficulty of transportation from the hills. The total annual supply from the Punjab and the U.P. is estimated to be about 2,000 tons (Pearson and Brown, *loc. cit.*).

The fruits are given to horses for colic. An oil from the seeds is used externally in rheumatic complaints. The leaves and twigs are lopped for fodder and the fruits are eaten by the hill tribes in times of scarcity.

AFRAMOMUM K. Schum. ZINGIBERACEAE

D. E. P., I, 222.

A genus of herbs, comprising 50 species found in tropical Africa. *A. melegueta* (Rosc.) K. Schum. (syn. *Amomum melegueta* Rosc.) and *A. granum paradisi* K. Schum. are the source of the African spice, 'grains of paradise'. *A. melegueta* is occasionally cultivated in Indian gardens. Its seeds are pungent and are used in veterinary medicine and for flavouring cordials and liquors.

The seeds yield 0·3–0·75% of an essential oil (sp. gr., 0·897; ester val., 41·2; and ester val. after acetylation, 63·9, Parry, I, 105). Their pungency is due to paradol, a yellow oily substance, similar to gingerol, present in the fatty oil of the seeds (0·75%, Wehmer, I, 182).

AFZELIA Sm. LEGUMINOSAE

D. E. P., I, 128 Fl. Br. Ind., II, 274.

A genus of 12 species of trees, distributed in tropical Asia and Africa, four of which are found in India. *A. bijuga* A. Gray is a medium-sized tree, found in the coastal forests of Bengal (Sunderbans), Burma and the Andamans. Its sapwood is light-brown; the heartwood is reddish brown. It is moderately hard and durable and is used in the Andamans for beams and girders (Gamble, 280).

AGANOSMA G. Don APOCYNACEAE

D. E. P., I, 128; Fl. Br. Ind., III, 663.

A genus of latex-bearing, evergreen woody climbers, comprising about 8 species, mostly confined to the moister parts of India, Malaya and south China. Some are medicinal, e.g., *A. dichotoma* (Roth) K. Schum. (syn. *A. caryophyllata* G. Don) and *A. marginata* G. Don. The latter is found in Sylhet, Chittagong, Tenasserim and Malaya. A decoction of its root is taken for urinary troubles, as a tonic for fever and as an emmenagogue (Burkill, I, 61).

AGATE

Pl. X.

Chalcedony, of which *agate* (SANS.—*Gomed*; HIND.—*Akik*) is a banded form, is a cryptocrystalline quartz, SiO_2, generally white, greyish or delicate blue in colour, and translucent to opaque with a waxy or greasy lustre. Agate usually shows coloured bands which may be clearly marked off or may shade into one another. The porosity of the layers in banded agate facilitates artificial colouring. *Moss agate* or *mocha stone*, with its dendritic inclusions of chlorite, manganese oxide, iron oxide, etc., *onyx* with its black and white parallel alternating layers, and *sardonyx* with its brownish red (or red) and white bands, are all varieties of agate.

The other varieties of chalcedony are *carnelian* (clear-red), *sard* (brownish-red), *chrysoprase* (apple-green), *prase* (dull leek-green), and *plasma* (bright green and sub-translucent). Plasma containing small spots of jasper (red opaque quartz) is known as *bloodstone* or *heliotrope*. *Buhrstone*, or *burrstone* is a white, grey or yellowish, hard chalcedonic stone.

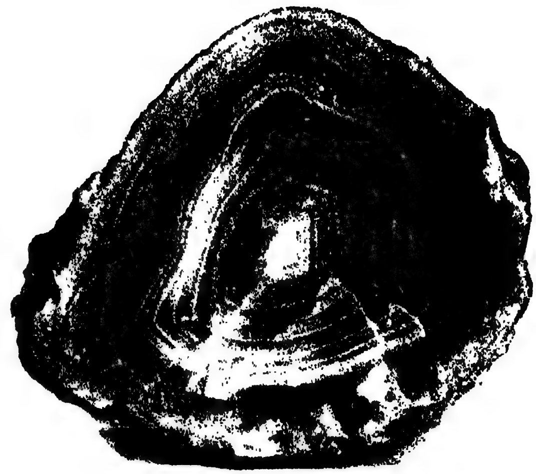
Beads of beautiful workmanship made out of agate and other varieties of chalcedony have been unearthed in Mohenjo-daro. India's onyx and carnelian cups, and chalcedony have been known all over the world since Greek and Roman times.

DISTRIBUTION

Chalcedony and agate are commonly observed filling the cavities in the different volcanic rocks of India, including the Deccan Trap in Bombay, Central Provinces, etc., the Rajmahal Trap in Bihar and the Panjal Trap in Kashmir, and less commonly in the lavas of the Abor volcanic series in Assam, in the basalts of Pavagad (Baroda), and the tuffs of the Malani series, Jodhpur. The Deccan Trap is by far the most important source, and large amounts of chalcedony and agate may be collected from the beds of rivers draining the Trap. At certain places, Tertiary and Sub-Recent conglomerate beds are almost entirely made of pebbles of agate and chalcedony. Small veins of chalcedony are also occasionally seen to traverse the lavas of the Deccan Trap.

Bihar: Along with other forms of quartz, agate and chalcedony occur in the Rajmahal hills. They are most abundant in the lava flows which underlie the white and the yellowish shales. A locality specially mentioned is about two miles to the north of Barhait (24°53′ : 87°37′) where a bed rich in agate nodules runs for nearly a mile (*Rec. geol. Surv. India*, 1921, **53**, 265).

1. AGATE (Cross Section)



2. AGATE (Cross Section)

3. KNIFE MADE FROM NARBADA VALLEY AGATE

4. PAPER WEIGHT OF MOSS AGATE

Bombay: Varieties of agate are common as amygdales in the Deccan Trap. On weathering the stones get dislodged and collect in the gravels. The most important centres of production in this part were Ratanpur (21°43′ : 73°11′) and Damlai (21°42′ : 73°13′) in Rajpipla State where agate and carnelian occur in a conglomerate of the Pilocene age (*Rec. geol. Surv. India*, 1909, **37**, 176). The mines, however, have not been worked since 1929.

A large quantity of agate occurs in the pebble bed near Ranpur (22°21′ : 71°42′) in Ahmedabad dist. and in the bed of the Majam river between Mandva and Amliyara (23°13′ : 73°4′). Here agates are veined and take a high polish. In Kaira dist., a particularly beautiful variety of agate occurs at Kapadvanj (23°1′ : 73°4′). Some of the stones bear markings resembling landscape and are highly prized.

In Kathiawar, a large irregular vein of moss agate traverses the Deccan Trap at Khijaria, three miles WNW. of Tankara (22°40′ : 70°48′) in Morvi State. Another vein of moss agate occurs about half a mile to the SW. of Khakhra (22°20′: 70°30′). Common agate of greyish white colour is also known to occur in the same neighbourhood. Fragments of moss agate occur scattered on the surface at Latipur (22°37′ : 70°35′) and in its vicinity as also between Jiwapur (22°49′ : 70°40′) and Badanpur (22°47′ : 70°40′) in Navanagar State. A number of localities from Navanagar State and Kathiawar are reported to be particularly rich in onyx. These include Vijarkhi (22°25′ : 17°30′), Khokhri (22°23′ : 70°28′), Baolidar (22°9′ : 70° 13′), Bori (Bodi, 22°9′ : 70°18′) and Narmana (22°5′ : 70°13′).

In Baroda State, agate (usually banded and associated with bloodstone and jasper) occurs as pebbles in surface soils up to a depth of 1½–3′ near Naroli Nahani and Ghalha. In the latter area, agate pebbles vary from half a pound to three or four pounds in weight (Shah, 97).

Central India: A bed of siliceous breccia (the topmost bed of the Semri series) about 40′ thick, bearing agate, jasper and chert occurs in Bundelkhand (*Mem. geol. Surv. India*, 1859, **2**, 13). Agate pebbles are quite common in the valley of the Johhilla river in Rewah State. They are derived from the druses of the trap rocks found in many parts of south Rewah. Here agate is associated with jaspers and bloodstones. Chalcedony occurs notably in the Mahanadi valley, west of Chandia (23°39′ : 80°42′).

Agate and chalcedony occur as amygdales in the trap rocks of Gwalior State, notably on the hill near Harinkheri. Chalcedony (with opal) has been reported to occur in the geodes of the Deccan Trap in Khilchipur State.

Central Provinces: In the Central Provinces, as in Bombay, the amygdales in the Deccan Trap consist of different varieties of agate and chalcedony in large quantities and a substantial supply is obtainable from the gravels of rivers, notably in the Narbada valley.

Eastern States: Along with flint and jasper, agate is reported to occur in some profusion at places in the Bamanghati subdivision of Mayurbhanj State (*Rec. geol. Surv. India*, 1904, **31**, 173).

Hyderabad State: Pebbles of agate, onyx and carnelian are found in a calcareous conglomeratic bed between Herur Buzurg and Ferozabad. Plasma chrysoprase and bloodstone have been found in the Deccan Trap.

Kashmir: Fine agates and carnelians are reported to occur in a ravine at the place where the Chankang spur abuts on the Kyango Traggar (34° 20′ : 79°18′).

Madras: Large quantities of agate and chalcedony, etc. often accumulate in the beds of the rivers draining the Deccan Trap. A particularly rich locality is the bed of the Godavari near Rajahmundry. The gravels in the valley of the Kistna in Painad are also a rich source. A large number of fragments of carnelian along with jasper and chert occur in a conglomerate bed amongst the Pulivendla quartzite in the hills WSW. of Cuddapah (*Mem. geol. Surv. India*, 1872, **8**, 172). A certain amount of chalcedony occurs in association with quartz, reefs, e.g. in the auriferous reefs across the eastern spur of Bensibetta (11°42′ : 77°17′) in north Coimbatore (*Mem. geol. Surv. India*, 1901, **33**, ii, 55).

Rajputana: Agate has been reported from Sultanpur, Junera and Moali in Kotah State.

United Provinces: Agates occur in the gravel beds in Banda district.

MINING, PRODUCTION AND USES

The most important workings of agate are those of Ratanpur, Damlai and other places in Rajpipla State (Bombay), where they have been exploited for centuries (for an account of the agate industry in Rajpipla *vide*, Bose, *Rec. geol. Surv. India*, 1908, **37**, 176). The agate pebbles (usually 2–3″ along the longest diameter) as raised from the mines are light coloured, generally with a slight milky tinge. They are chipped at the mines to see if there are any flaws and the approved pieces are taken to Limodra where they are baked to improve and fix the colours. The stones are then sent to Cambay for cutting and polishing.

There are no reliable statistics of production of agate, carnelian, etc., though these minerals have been produced in India since very ancient times. Large quantities of agate have been exported from Cambay to Europe, Nigeria, Gold Coast, Africa and China, but in recent times increased foreign competition has adversely affected the industry.

The mines of Rajpipla State used to yield 100–500 tons per annum (Coggin Brown, 299). They were closed down in 1917, but yielded about 7·5 tons in 1929, valued at Rs. 8000.

Agate and other clear translucent varieties of chalcedony are of value as semi-precious stones. The stones are carved into a great variety of ornaments like necklaces, rings, amulets, ear-rings, brooches, wristlets, beads, etc. For cameos, onyx is preferred, since it has layers of different colours and straight banding. The top layer is used for the head, while the lower layer of another colour forms the background. Agate and chalcedony are also used for making small pestles, mortars and knife-edges of balances for scientific work.

The different layers of agate vary in porosity; hence some layers absorb a dye or a chemical, while others lacking in porosity take on little or no colour. Artificial colouring of agate has been practised in Germany for over a hundred years. Agate can be coloured red by soaking it for several weeks in a strong solution of iron nitrate. It is then gradually heated to a high temperature in an oven, and slowly cooled. If nickel nitrate is used instead, it is coloured apple-green. Black colours are developed by soaking agate in a solution of sugar and subsequently boiling the stone in sulphuri acid for several hours (Baxter, 269).

In India, agate articles are manufacture at Cambay (Kathiawar), Banda (U.P.), Jubbulpore (C.P.), and a few more places in the Deccan Trap area. To bring out the deep colours, the pebbles are first baked in earthen pots over a steady fire, and the stones are then cut at one end and sorted. In shaping them only simple tools such as handsaws, iron spikes, etc., are employed. Diamond-tipped drills are sometimes used for making delicate articles. The finished pieces are finally smoothened and polished. At Cambay, about Rs. 10,000 worth of agate is processed annually, the value of the finished articles being estimated at Rs. 6 lakhs (Trivedi, 312).

AGAVE Linn. AMARYLLIDACEAE

Agave is a large genus of short stemmed half-woody plants, bearing a rosette of long, erect, pointed, fleshy leaves. About 275 species are distributed in tropical America, whence many have been introduced into other tropical countries. Agaves were introduced into India in the 15th century by the Portuguese and they are now completely naturalised throughout the country. In north India, they are called *Rakas patta* and in the south they are known as *Kattalai* and *Kattazha*.

The leaves of agaves yield a valuable fibre. *A. cantala* is grown in the Philippines, Java and Cuba; *A. fourcroydes* Lem., a native of Mexico, is cultivated chiefly in Yucatan and yields the Henequen or Mexican fibre, and *A. sisalana*, the source of the wellknown sisal fibre, a native of Central America, is now grown largely in east Africa and to a smaller extent in the Bahamas, Java and Florida. *A. vera-cruz*, *A. heteracantha* Zucc. (Jaumave istle), and *A. lecheguilla* Torr. (Tula istle) yield fibres of inferior quality.

A. cantala, *A. sisalana*, and *A. vera-cruz* occur in India. They are planted along railway embankments and road-sides and are suitable for hedging and fencing. They may also be planted to check soil erosion. Experimental plantations are found in various parts of India. Agaves are capable of growing on rough dry soils which are unsuitable to other plants, but grow vigorously on dry, well-drained sandy loam. They rarely set seed, and propagation is carried out by means

of bulbils and suckers. The leaves are ready for extraction of fibre usually in the fourth year.

Agave fibre is one of the important hard fibres. In America, it ranks next to cotton, and the trade amounts to over $35,000,000 (Hill, 40). Agave fibre is mostly used for making ropes, cordage and twine. The shorter fibres and istles are used for making mops and brushes. Sisal is eminently suited for cordage of all kinds and trials carried out at the Imperial Institute, London, in co-operation with the Admiralty have shown that, for marine cordage the fibre compares favourably in durability with Manila hemp from *Musa textilis* Nee (Imp. Inst., Lond., Empire fibres for Marine Cordage,1935). In recent years, it has also been used for the manufacture of coarse fabrics. It is commonly used for binders, twine, fishing nets, hammocks, door mats, rugs, carpets, etc. The refuse left after decorticating the leaves is employed in making paper and paper-boards.

Agaves flower only once during their life and the flowering stem arises from the centre of the plant as a thick pole, which rapidly grows to a height of 20–30′. They die after fruiting. On cutting off the young flowerhead of *A. americana* Linn. (Century plant, American aloe; found in India only as a garden ornamental plant), a large quantity of juice is obtained. This, when fermented, yields *pulque*, the national drink of Mexico; the distilled spirit is known as *mescal*.

A. angustifolia Haw. Syn. *A. wightii*, Drummond & Prain THE DWARF ALOE

C. P., 34; Drummond and Prain, *Dep. Land Rec. and Agric., Bengal, Bull.*, No. 8, 1906, 11.

A plant with stout trunk and a stiff, compact rosette of leaves about 2′ long and 3″ broad at the middle, and with weak marginal prickles. It is naturalised in the sub-Himalayan tract and outer Himalayas and many other parts of India. In the plains, it is grown as a fence along railway lines.

The leaves yield a short fibre, of little use for commercial purposes.

A. cantala Roxb. MAGUEY, CANTALA, BOMBAY ALOE

C. P., 33; Drummond and Prain, *Dep. Land Rec. and Agric., Bengal, Bull.*, No. 8, 1906,11.

A. cantala has a short ascending rootstock, and long narrow leaves, 4′ or more in length and 3″ wide at the middle. It is commonly met with in Bombay, Deccan, northern Madras, the Central Provinces, the United Provinces and parts of the Punjab. The plant grows well as a hedge and is useful in checking soil erosion. It needs a fairly good soil and thrives best in regions with 40–100 inches rainfall.

The leaves yield 3–4·5% of fibre. In Bombay, the fibre is extracted on a commercial scale, generally by retting. This fibre is mostly utilised for the manufacture of ropes. It is also used by the mat weavers of Travancore. Mechanically decorticated fibre is finer, though less tensile than sisal. It is also useful for cordage twines, nets, etc.

A. sisalana Perr. Syn. *A. rigida* Mill. var. *sisalana* SISAL

D. E. P., I, 143; C. P., 34; Emp. Marketing Bd., Empire Grown Sisal, 1928,

The sisal agave has a short stem, 15″ thick bearing a number of dark green, thick, fleshy, rigid leaves, 4–6′ in length and 4–6″ in width at the broadest portion. Generally no spines are found on the leaf margin.

Sisal has been cultivated on an experimental scale in Assam, Bengal, Madras, Bombay, Mysore and Ceylon. It grows well on a dry, permeable sandy loam and is exceedingly draught-resistant. Propagation is usually carried out by bulbils or suckers. Bulbils are grown in nursery beds and seedlings are transplanted when 8-12″ high. They are usually spaced 8′ apart in rows of 6′. The leaves are cut for fibre between the third and the fourth year. The oldest leaves (the lowest on the trunk) are cut close to the trunk. Each plant yields about 250–300 leaves during its life-time of 7–8 years (Emp. Marketing Bd., Sisal, 1933).

Where sisal is cultivated on a large scale, as in East Africa, the fibre is extracted by mechanical decorticators. It is then washed, cleaned, dried and packed in bales. But in India, though the plant was introduced on a commercial scale some time ago, there are very few plantations of any size. Ordinarily, the leaves are scraped by hand to remove the green matter from the fibrous layer, or they are passed through a cane-crushing mill and then retted in water for

about 8–15 days. The fibre is then finished in the usual manner (*Dep. Agric. Bengal, Leafl.*, No. 2, 1940, 2).

The average weight of a sisal leaf is approximately 2 lb. and 1,000 leaves yield 60–80 lb. of dry fibre. Although fibre content is as high as 6–8%, only 3–4·5% is obtained by decortication. Sisal hemp consists of strands or filaments 3–5′ long, of a mealy white or pale yellowish colour. The fibre is strong, coarse, somewhat harder and more flexible than Manila hemp. The fibrous substance consists of 73–78% of a lignified form of cellulose (*Bull. imp. Inst., Lond.*, 1930, **27**, 441).

Fibre from East Africa is exported mostly to London, and that from Mexico and the Dutch East Indies to the U. S. A. During the second World War, the price was £30–40 a ton, the normal price being £20–25 a ton. In India, it is valued at Rs. 250 per ton (Sircar, 7).

The dried residue left after the extraction of fibre contains 11% of fermentable sugars (Wehmer, I, 166), but it is not profitable to prepare alcohol from it (Greenstreet, *Malay agric. J.*, 1930, **18**, 305).

A. vera-cruz Mill. THE BLUE ELEPHANT ALOE

C. P., 34; Drummond and Prain, *Dep. Land Rec. and Agric., Bengal, Bull.*, No. 8, 1906, 10; and *Agric. J. India*, 1908, **2**, Pl. 43.

Probably a native of Mexico, naturalised throughout India, and common in Assam, Bengal, Bihar, Bombay and in south India. The leaves yield 1·5–2·5% of a fibre, which is coarser and stronger than cantala fibre. It is useful for ropes, cordage and mat making.

AGERATUM Linn. COMPOSITAE

A genus of aromatic herbs, comprising 45 tropical species.

A. conyzoides Linn. GOAT WEED

Fl. Br. Ind., III, 243; Pl. VIII, 2.

BENG.—*Uchunti*; TAM.—*Pum-pillu*; KAN.—*Nayitulasi*; SINH.—*Hulan tala*.

A common hairy annual weed, 1–3′ high, found throughout India up to 5,000′, and in Ceylon.

The leaves of the plant are used for cuts and sores, and as an external application in ague (Dymock, Warden & Hooper, II, 244).

According to Moudgill (*J. Indian chem. Soc.*, 1925, **1**, 273) the leaves and flowers yield 0·02% (dry wt.) of essential oil possessing a powerful, nauseating odour. Joly (*Chem. Abstr.*, 1937, **31**, 2650) found the oil of the African species to be agreeable. This consisted almost entirely of a phenolic ester similar to ethyl eugenol.

The oil from Annam has been examined by Bertrand (Finnemore, 826).

AGLAIA Lour. MELIACEAE

A large genus of trees and shrubs, comprising 125 species, distributed in the Indo-Malayan region and southern China. About 20 species are reported to occur in India. Most of the species yield hard wood. The woods of *A. maiae* Bourd. and *A. minutiflora* Bedd., are somewhat pink and fragrant. *A. odorata* Lour., a Malayan species with sweetly scented flowers, is occasionally cultivated in Indian gardens. In Malaya, its flowers and leaves are regarded as medicinal (Burkill, I, 75). The fruit of *A. edulis* A. Gray is edible.

A. roxburghiana Miq.

D. E. P., I, 145; Fl. Br. Ind., I, 555; Brandis, Fig. 67.

TEL.—*Yerra aduga*; TAM.—*Chokkala*; MAL.—*Punyava*.

A large tree, confined to the western Peninsula. In Ceylon, it ascends to 6,000′. Two well-marked varieties, var. *beddomei* and var. *courtallensis* are recognised.

The wood is bright red, very hard and tough and is classed among refractory timbers. It weighs 58–61 lb. per c. ft. (Gamble, 149).

The fruit is edible. It is regarded as cooling and astringent and is used in inflammations (Dymock, Warden & Hooper, I, 343).

AGLAONEMA Schott ARACEAE

Fl. Br. Ind., VI, 528.

A genus of herbs comprising 45 species, found in eastern India, Malaya and southern China. Some of the species are cultivated for their glossy leaves and bright red berries. A few are medicinal in Malaya (Burkill, I, 76).

AGRIMONIA Linn. ROSACEAE

D. E. P., I, 146; Fl. Br. Ind., II, 361.

A small genus of herbs, comprising some ten species found in temperate regions. *A. eupatoria* Linn. (Agrimony) is a perennial hairy herb, found in the Himalayas from Murree and Kashmir to Sikkim (7,000–10,000′), and in the Khasi hills (4,000–6,000′). It has long been used in Europe as an astringent and tonic. The plant has been reported to yield a dye (Louschovskaya, *Chem. Abstr.*, 1937, **31**, 6883).

AGROPYRON J. Gaertn. GRAMINEAE

A genus of annual or perennial grasses with creeping rhizomes, comprising about 60 species, distributed in the temperate regions. Six species occur in India.

A. repens Beauv. COUCH GRASS

Fl. Br. Ind., VII, 370.

This grass occurs in Kashmir at altitudes of 9,000–12,000′. It was introduced from Europe into America and now it has become a troublesome weed in both the continents.

The rhizome is somewhat cylindrical, longitudinally furrowed, with circular leaf scars and is light yellow in colour. The fracture is tough and fibrous. It has a sweet taste.

The rhizome is demulcent and diuretic. It has been found to contain triticin (5%), a laevorotatory carbohydrate resembling inulin. Two glycosides have also been reported, one of which yields vanillin on hydrolysis. Starch is absent (Trease, 132).

AGROSTIS Linn. GRAMINEAE

D. E. P., I, 147.

A genus of perennial (a few annual) pasture grasses, comprising about 125 species, confined to the temperate regions. About 12 species are met with in India, at higher elevations. *A. alba* Linn. (Fiorin or White Bent grass) and *A. canina* Linn., found in the western Himalayas and Nilgiris, are regarded as good fodder grasses.

AGROSTISTACHYS Dalz. EUPHORBIACEAE

A genus of shrubs or small trees, comprising 11 species, of which about 3 occur in India and Ceylon.

A. meeboldii Pax and K. Hoffm. Syn. *A. longifolia* Benth.

Fl. Br. Ind., V, 407.

A small tree about 12′ high, bearing large, thick leathery leaves up to 16″ in length. It is found in the evergreen forests of south India (2,000–5,000′), in Ceylon, and in the Andamans.

The wood is pale brown, and moderately hard. It weighs 38 lb. per c. ft. (Gamble, 617). It is used in Ceylon for rafters and posts in temporary buildings. The leaves are used for thatching (Lewis, 338).

AILANTHUS Desf. SIMAROUBACEAE

This genus includes about 8 species of trees and shrubs, distributed in southern Asia and Australia. Four species occur in India. *A. glandulosa* Desf., [=*A. altissima* (Mill.) Swingle] a native of China and Japan, is an ornamental tree occasionally planted in northern India. *A. malabarica* yields an aromatic resin. The timber of some species is soft and light and that of *A. grandis* Prain (Assam and Darjeeling hills), is found suitable for plywood tea chests (Limaye, *Indian For. Rec., New Series, Util.*, 1942, **2**, 186).

A. excelsa Roxb.

D. E. P., I, 148; Fl. Br. Ind., I, 518; Talbot, Pls. 126 & 127.

SANS.—*Madala*; HIND. & MAR.—***Maharuk***; GUJ.—*Ardusi*; TEL.—*Peddamanu*; TAM.—*Perumaram*; KAN.—*Doddamara*; MAL.—*Matti pongilyam*.

A large deciduous tree, 60–80′ in height and 6–8′ in girth, with rough, light grey bark. It is found in Bihar, Chota Nagpur, the Central Provinces, Gujarat, and in the forests of Ganjam, Vizagapatam and Deccan.

The wood is yellowish white and lustrous when first exposed, turning greyish white with age. It is very light, soft and perishable (sp. gr., 0·45; air-dry wt., 27 lb. per c. ft.). The timber is used for packing cases, fishing floats, boats, spear sheaths, sword handles, toys and drums (Pearson and Brown, I, 216).

The tree yields an inferior type of Bassora or Hog gum. Its bark is used as a febrifuge and tonic (Kanny Lall Dey, 15).

A. malabarica DC.

D. E. P., I, 151; Fl. Br. Ind., I, 518; Beddome, Pl. 122.

TEL.—*Peddamanu*; TAM.—*Perumaram*; KAN.—*Hal-maddi*; MAL.—*Mattipal*.

This is a large tree with a tall cylindrical trunk and thick rough grey bark, often with bright red-coloured grains of resin. It is found in the evergreen forests of the Western Ghats (up to 5,000′), in Pegu Yoma (Burma), and in Ceylon.

A highly viscous aromatic resin is obtained, when incisions are made in the bark. If left for a long time, it becomes brittle. It is collected for local use as incense and forms an ingredient of *agar-battis*.

The wood is very light and soft and can be used like that of *A. excelsa*.

Ajava or **Ajwan seeds**, see **Trachyspermum ammi**

AJUGA Linn. LABIATAE

D. E. P., I, 152.

A small genus of hairy herbs, comprising about 30 species found in the temperate regions. *A. bracteosa* Benth. is a perennial herb found in the western Himalayas from Kashmir to Nepal (7,000′) and in the Upper Gangetic plain. It is said to be astringent and febrifuge. The aromatic leaves are regarded as stimulant, diuretic and aperient.

Akund, see **Calotropis gigantea**

ALANGIUM Lam. ALANGIACEAE

A genus of shrubs or trees, comprising about 22 paleotropical species. Two species are found in India.

A. salviifolium (Linn. f.) Wang. Syn. *A. lamarckii* Thw.

D. E. P., I, 153; Fl. Br. Ind., II, 741; Pl. VIII, 3.

SANS.—*Ankola*; HIND.—*Akola*; BENG.—*Akarkanta*; MAR.—*Ankol*; GUJ.—*Onkla*; TEL.—*Ankolamu*; TAM.—*Alangi*; KAN.—*Ankole*; MAL.—*Irinjil*.

A small deciduous tree, shrub or straggler, found in the drier parts of India and Ceylon and growing vigorously in the forests of south India and Burma.

The root bark is anthelmintic and purgative. It is useful in fevers and skin diseases, and is generally administered in the form of powder.

Chopra and Chowhan (*Indian J. med. Res.*, 1934, **21**, 507) have isolated an amorphous alkaloid alangine (0·8%; m.p., 80–82°) from the bark. In small doses, the alkaloid lowers blood pressure temporarily, depresses the heart and produces irregular respiration. It also increases peristaltic movement of the intestines.

The wood is olive-brown, hard and close-grained and weighs 42–56 lb. per c. ft. (Gamble, 389). In south India, it is used for pestles, oil-mills, cattle-bells, etc. It is suitable for inlaying and carving. The wood is also used as fuel.

The fruit is edible. The seeds contain alkaloids (0·2%), and a sterol of m.p., 302–307°, but very little fatty oil (Lakshminarayaniah, Manjunath and Nagaraj, *J. Mysore Univ.*, 1942, **3**, 113; Bhargava and Dutt, *Proc. Indian Acad. Sci.*, 1942, **16 A**, 328).

ALBIZZIA Durazz. LEGUMINOSEAE

This is a genus of medium-sized trees, including 50 species found in the warmer parts of the world. About 12 species occur in India. A few of them yield valuable timber and that of *A. lebbek* is known in Europe as 'East Indian Walnut'. Several albizzias are cultivated as avenue trees, and as shade trees in coffee and tea plantations.

A. amara Boiv.

D. E. P., I, 155; C. P., 45; Fl. Br. Ind., II, 301; Beddome, Pl. 61.

MAR.—*Lallei*; GUJ.—*Moto sarsio*; TEL.—*Nalla renga*; TAM.—*Wunja*; KAN.—*Chigare*; MAL.—*Varacchi*.

A moderately-sized, much-branched deciduous tree, with a crooked bole up to 8–10′ and a girth of 2–3′. It is found throughout the drier regions of south India and Ceylon, and is also met with in a few localities in the Central Provinces. It is sometimes grown as an avenue tree.

The wood is heavy, straight-grained and medium textured (sp. gr., 0·84; air-dry wt., 54 lb. per c. ft.), sapwood is white, and heartwood is light brown, often with a purplish cast mottled with dark and light shades. Anatomically it is featured by inconspicuous growth rings, fairly large pores, surrounded or occasionally bridged by parenchyma and very fine rays, which form

a faint fleck on the radial surface (Pearson and Brown, I, 469).

The timber seasons well. It should be converted green and open-stacked under cover. It works to a fine, smooth surface, and takes polish well.

It is very strong and moderately hard, and is therefore useful in making tool handles, mallet heads, brake blocks, etc. It is commonly used for carving turnery and agricultural implements. It is a first class cabinet-making wood.

The leaves are said to be used for adulterating tea. According to Bourdillon (143) the tree is cultivated in S. Travancore chiefly for green manure.

A. lebbek Benth. SIRIS TREE, EAST INDIAN WALNUT

D. E. P., I, 156; C. I., 45; Fl. Br. Ind., II, 298; Pl. IX. 2.

SANS. & MAR.—*Sirisha*; HIND.—*Siris*; BENG.—*Sirish*; GUJ.—*Pilo sarshio*; TEL.—*Dirasana*; TAM.—*Vagei*; KAN.—*Bagemara*; MAL.—*Vaga*; BURM.—*Kokko*; TRADE—Kokko.

A large, erect deciduous tree with an umbrella-shaped crown. It has a clear bole of 20–30′ and attains 6′ in girth. In the Andamans, it reaches from 60–100′ in height, and a girth of 6–10′ is common. The tree is common throughout India except in Sind. It is found all over Burma and in the Andamans. It occurs scattered in mixed deciduous forests and ascends to 4,000′ in the Himalayas.

The tree prefers moist situations, and is found to grow on a variety of soils. It can be grown by line sowings on well-loosened soil. Transplantation of nursery plants and propagation by cuttings are both satisfactory. The rate of growth is very rapid.

The wood is light, coarse-textured, and has broadly and shallowly interlocked grain (sp. gr. 0·61; air-dry wt., 39 lb. per c. ft.). The sapwood is white or yellowish white, and the heartwood is dark brown, streaked with dark and white shades. It is anatomically characterised by distinct but inconspicuous growth rings, large pores, with eyelets of parenchyma, conspicuous vessel lines along the grain, and fine wood rays (Pearson and Brown, I, 456).

The timber seasons well and kiln-seasoning presents no difficulty. If left in log, it is liable to fungal attacks and damage by borers. It should be converted and close-piled under cover. It is difficult to saw and machine because of the broadly interlocked nature of the grain. During sawing a fine irritant powder separates out. If the large pores are filled in, it takes a good polish.

The wood is excellent for high class furniture, internal decoration and panelling, and is valued for parquet and strip flooring, panelling and railway carriage work. It is useful for construction purposes, agricultural implements, oil-pressers and cane-crushers. It is also useful for making carts and carriages, for well-curbs, carving, etc. It is also a good fuel wood (cal. val. of moisture-free heartwood, 5166 cals., *Indian For. Bull., New Series*, No. 79, 1932, 11).

The bulk of the supplies comes from the Andamans. Limited quantities are available from many provinces in India.

A reddish brown gum exudes from the bark and dries into stalactiform masses. It has a smooth polished surface. It gelatinises with a large amount of water and is not completely soluble. It is adulterated with gum arabic (q. v.) and is used for the same purposes as the latter.

The bark contains tannin (7–11%), and some saponin. It is said to be used in Madras to tan fishing nets. The tree is planted along roadsides and in gardens. It is grown for shade, in tea and coffee plantations, and the shed leaves make good manure. The leaves and twigs are lopped for fodder.

A. lucida Benth.

D. E. P., I, 158; Fl. Br. Ind., II, 299.

BENG.—*Sil koroi*; NEP.—*Tapria siris*; LEPCHA—*Ngraem*; BURM.—*Thanthat*.

A medium-sized deciduous tree found from Nepal eastwards to Assam, and in the tropical forests of Burma. It is found wild along the banks of streams, and in moist places. It is often planted along avenues and in gardens.

The wood is moderately heavy, brown or dark brown in colour, and is comparable to that of *A. amara* (sp. gr., 0·67; air-dry wt., 38–43 lb. per c. ft.). In structure, it differs from *A. amara* in having wider pores and broader rays (Pearson and Brown, I, 467). It may be used for posts, rafters and scantlings.

This tree is one of the minor hosts of lac.

A. odoratissima Benth.

D. E. P., I, 158 ; C. P., 45 ; Fl. Br. Ind., II, 299 ; Beddome, Pl. 54.

BENG.—*Kakur siris* ; HIND.—*Kala siris* ; MAR.—*Chikunda* ; GUJ.—*Kalo sarasio* ; TAM.—*Karuvagei* ; TEL.—*Chinduga* ; KAN.—*Bilvara* ; MAL.—*Puli vaga* ; BURM.—*Thitmagyi* ; TRADE—Black Siris.

A large erect tree with 25–30′ clear bole, and drooping dark green foliage, found throughout India, Burma and Ceylon. It ascends to 5,000′ in the sub-Himalayan tract. It grows sporadically in mixed deciduous forests and is common on hill slopes. It is planted in tea gardens for shade.

The wood is fine-textured and moderately heavy, but in other respects resembles that of *A. lebbek* (sp. gr., 0·67 ; air-dry wt., 43 lb. per c. ft.). The timber seasons well. It is moderately durable and fairly resistant to white ants. It is difficult to saw and work, as it shows a tendency to chip. With care, it works to a smooth, shiny surface and takes a good wax polish.

The wood is used for construction purposes, carts and cart accessories, agricultural implements, oil-mills, etc. It is valued for furniture, decorative work and panelling. Tests at the Royal Aircraft Establishment have proved this wood to be suitable for propeller blades (Pearson and Brown, I, 461).

A. odoratissima yields a dark brown insoluble gum in the form of rounded tears. It is similar to the gum of *A. lebbek*. The leaves and twigs are lopped for fodder.

A. procera Benth.

D. E. P., I, 159 ; C. P., 45 ; Fl. Br. Ind., II, 299.

HIND.—*Safed siris* ; BENG.—*Koroi* ; MAR.—*Kinhai* ; TEL.—*Tella chinduga* ; TAM.—*Konda vagei*, KAN.—*Bellate* ; MAL.—*Karun thagara* ; BURM.—*Sit* ; TRADE —White Siris.

A large deciduous tree, 60–80′ high, growing to 6′ and over in girth. It is common in the sub-Himalayan tract from Jumna east-wards to Bengal and extends to south India. It also occurs in the Andamans and in Burma. It grows on alluvial ground along streams and other moist situations. It is cultivated in gardens and planted along road-sides.

The wood is very similar to that of *A. lebbek*, but is lighter and softer (sp. gr., 0·60 ; air-dry wt. of sapwood, 29 lb. per c. ft., and of heartwood, 40 lb. per c. ft.).

The timber kiln-seasons easily. As the sapwood is quickly perishable, it should be removed as soon as possible. Heartwood is durable even in exposed situations. It is hard and somewhat difficult to saw as the grain is more broadly interlocked than in the wood of *A. lebbek*. With care, it can be worked to a good surface and polished well.

It is chiefly used for construction purposes, furniture, for carts and carriages, etc. It is also used for dug-outs, oars, cane crushers, rice pounders and, in Assam, for carving.

A. stipulata Boiv.

D. E. P., I, 160 ; C. P., 45 ; Fl. Br. Ind., II, 300 ; Beddome, Pl. 55.

HIND.—*Siran* ; BENG.—*Chakua* ; MAR.—*Laeli* ; TEL.—*Konda chiragu* ; TAM.—*Pili vagei* ; KAN.—*Hotta bage, kal bage* ; MAL.—*Potta vaga* ; BURM.—*Bonmeza*.

A large deciduous tree with a broad spreading and flat-topped crown. It has a cylindrical bole of 30′ which attains 8′ in girth. It is found throughout the sub-Himalayan tract up to 4,000′ in Bengal, Assam and south India. It is also met with in the Andamans, the Nicobars, Burma and Ceylon. It prefers moist situations. It is extensively cultivated for shade in coffee and tea gardens. It can be propagated by line sowings and cuttings.

The wood resembles that of other albizzias, but is lighter in colour (sp. gr., 0·42 ; air-dry wt., 22–46 lb. per c. ft., according to locality). It is not durable, being liable to insect attack. It is used for box-making, especially tea-boxes and packing cases. It is also used for planking, dug-outs, well-curbs, small turnery articles, etc. It can be used for agricultural implements and furniture.

A. stipulata yields an insoluble gum and is used by the Nepalese for sizing paper. The leaves and twigs are lopped for fodder.

ALBUMEN

Egg albumen belongs to a group of simple proteins known as albumins, found in plants (leguminous seeds and cereals) and animals. The latter are

a much richer source. Blood albumin is obtained from blood plasma (*vide* Blood), and lact-albumin from milk. Albumins are generally soluble in water and in moderately concentrated salt solutions. The solutions are coagulated by heat (70–75°).

Egg albumen, the white of egg, is a colourless or pale yellow fluid which forms about 58% (by weight) of the egg. It contains: water, 87; proteins, 12; and minerals, 1 per cent. It is also a good source of vitamin B_2. Egg albumin is composed of 5 different proteins, the chief of which is ovalbumin (75%. Thorpe, IV, 253). It is coagulated when heated to about 70°, and by alcohol. It forms precipitates with salts of most of the heavy metals, and with phenol and tannic acid.

Fresh white of egg, diluted with water to which a little salt is added (albumin water), is used as invalid food and in the diarrhoea of infants. Egg albumin is used in the treatment of burns and as an antidote to poisoning by mercuric chloride and by the soluble salts of other heavy metals. It is employed for the preparation of several albuminates for pharmaceutical use.

Dried egg albumen is prepared by the careful evaporation of the white of egg at temperatures not exceeding 50°. It is obtained in the form of yellowish transparent flakes, horny scales, or coarse powder. It dissolves gradually in 10 parts of water, but is more readily soluble in the presence of a little common salt. Its solution may be used as a substitute for fresh albumen. Dried egg albumen enters into confectionery and several food preparations. For these purposes, it is prepared in different forms by variations in the process of manufacture (*vide* Thorpe, *loc. cit.*; and *Chem. Abstr.*, 1943, **37**, 1779).

The chief industrial uses of egg albumen are in the preparation of adhesives, leather finishes, and photographic plates and papers. It is also used as a clarifying agent for wines and distilled liquors. For some of these purposes blood albumin is a cheaper substitute.

Alder, Indian—see **Alnus nepalensis**

ALEURITES Forst. EUPHORBIACEAE

Aleurites is a genus of 6 species of trees, distributed in the tropical and sub-tropical regions of eastern Asia and Malaysia. They are cultivated for their nuts which yield valuable drying oils. *A. fordii* and *A. montana*, of China and the Shan States, are the source of tung oil, also known as Chinese wood oil. *A. cordata* Steud., of Japan, sometimes planted in gardens in north-western India, gives the Japanese wood oil. *A. trisperma* Blanco of the Philippines also yields a useful drying oil. The oil of *A. moluccana* is of inferior quality.

A. fordii Hemsl. TUNG OIL TREE

D.E.P., I, 162; C.P., 46; Laurie and Sen Gupta, *Indian For. Rec., New Series, Silv.*, 1941, **4**, Pt. 3, Pls. 1 and 2.

A much-branched, short lived (about 30 years), deciduous tree with cordate leaves and monoecious flowers. The tree is usually 20–25′ high. The fruit is somewhat top-shaped, 1½–2″ long, equally broad, and contains 3–5 one-seeded segments. It has a smooth outer husk. The pericarp is pointed at the summit.

A. fordii grows abundantly in the cooler parts of central and western China and ascends up to 5,000′. It is also found in the Southern Shan States of Burma.

This species is the principal source of the Chinese tung oil, which is usually a mixture of the oil of this species and that of *A. montana* (about 10%). The trade does not make any distinction between the oils yielded by *A. fordii* and *A. montana* as they are similar in properties and commercial uses (Jamieson, 314).

Till recently, China was the principal source of tung oil, producing about 70,000 tons (1938) and exporting mostly to the U. S. A. The commercial importance of the oil, the increased demand for it, and the uncertainty of imports from China, prompted its cultivation in countries other than China, and experimental plantations were started in the U. S. A. at the beginning of this century. In 1944-45, there were over 175,000 acres under the cultivation of *A. fordii* in Mississippi, Louisiana and Florida, with an estimated production of 4,500 tons of oil (Bray, *Chem. & Industr.*, **1945**, 294. See also Ashby, *Bull. imp. Inst., Lond.*, 1940, **38**, 5).

CULTIVATION

Experimental cultivation in the British Empire commenced in 1927. In India and Burma, a few plantations were started in the tea estates of

Assam, Bengal and Bihar, and in Coorg and Mysore. In many cases, *A. fordii* was first tried and then *A. montana*. In general, the latter has been found to thrive better in Assam, Bengal, and in the area round Ranchi in Bihar (Laurie and Sen Gupta, *loc. cit.*). However there are, as yet, no large-scale commercial undertakings in India. In Burma five companies started plantations on a commercial scale and, by 1939, the estimated acreage under *Aleurites* was 10,000 acres. The Tung Oil Estates Ltd. (Burma) started with *A. fordii*, but meeting with limited success, later introduced *A. montana* (*Bull. imp. Inst., Lond.*, 1945, **43**, 14).

In its natural habitat, *A. fordii* is essentially a hillside plant and is said to flourish in rocky areas and on poor soils. It requires a cool climate, but is very frost tender. In India, the species has been successfully grown in moderately fertile, well-drained and slightly acidic soil. It cannot stand water-logging even for a short duration and it will not grow in alkaline soil with excess of lime and phosphate. An elevation of 2,500-3,500′ and a rainfall of about 50 inches is best suited to its growth (Biswas, *J. sci. industr. Res.*, 1945, **4**, 260).

The plants can be raised from seeds, either by direct sowing or by transplanting. Propagation by budding and by grafting is also suggested. For successful cultivation, fresh viable seeds weighing 160 to a lb. with 50% germinating capacity should be selected. To increase the yield, it is advisable to select seeds from dominantly female flowering trees, but vegetative propagation of high yielding trees will give sure results (Biswas, *loc. cit.*).

The nursery should be well-irrigated and drained. The period of germination may be reduced by treating the seeds with penetrants like morpholine (Shear and Crane, *Bot. Gaz.*, 1943, **105**, 251). The seeds should be husked just before sowing, and single seeds should be planted 8-12″ apart, at a depth of 3-4″.

The plants are transplanted after six months, at a spacing of 12½′ in rows 30′ apart. Before this, the field should be weeded, ploughed, and treated with leafmould, if the soil is not sufficiently rich in humus. Light manuring of the plantation is also recommended (Laurie and Sen Gupta, *loc. cit.*).

Ordinarily 75-100 trees are maintained per acre. The trees are comparatively fast-growing and attain a height of 8-10′ in the third year, when some of them begin to flower and bear fruit. The full bearing capacity is attained at the 10th year and the tree continues to bear fruits for another 20 years. A ten year old tree generally yields 50-60 lb. of fruits per season. The fruits yield 50-60% of nuts or seeds. In India and Burma, the seeds yield 55-60% of kernels which in turn yield 49-65% of oil. Seeds from China give 54% of kernels containing 58% of oil (Laurie and Sen Gupta *loc. cit.*).

Several insects are reported to cause damage to tung trees. Nandi (private communication) states that *Aspidiotus* sp. and *Serica* sp. cause damage to leaves while *Lactrostoma* sp. and *Anomala* sp. damage the bark. Several parasitic fungi on roots, branches and leaves have also been noted.

In China, the fruits are collected from trees, before they are fully ripe. The husks are removed either by heating the fruits in large iron pans over a fire or by collecting them into heaps and allowing them to ferment under a covering of straw. The oil is obtained by crushing the kernels in stone grinders or wooden presses. Seeds with a high moisture content yield very dark coloured oil (Jordan Tung Oil, 1927, 18). In America, the fruits are allowed to ripen and drop to the ground and the oil is expressed by up-to-date machines. American oil is pale yellow and more attractive in appearance and has the same properties as the Chinese oil.

TUNG OIL—PROPERTIES & USES

Tung oil is a very quick-drying oil (double the rapidity of linseed oil), and dries at a uniform rate instead of forming a skin like linseed oil, and unlike the latter, it dries flat, not glossy. When heated, it sets into a gel, the gelation time varying from 8-10 minutes. This is a characteristic property of the oil. The oil of *A. fordii* consists chiefly of the glycerides of α-elaeostearic and oleic acids.

In the following table, the constants of Chinese tung oil and the oils of *A. fordii* and *A. montana* are given :—

	Sp. gr.	n_D	Acid val.	Sap. val.	Iod. val.	Heat test (Min.)	Reference
Chinese oil . . .	0·936–0·949 at 15°	1·523/15°	up to 12	189–195	160–180	..	Hilditch, 128
American oil . .	0·9394/15·5°	1·5155/25°	0·64	192·3	165	10	Jamieson, 320
A. fordii (India) . .	0·9301/15°	1·514/25°	0·3	192·3	175·5	12	Laurie & Sen Gupta (*loc. cit.*)
A. montana (Burma) .	0·9467/15°	1·494/15°	3·4	203	141·4	16	Parker, Rao, Robertson & Simonsen (*Indian For. Rec.*, 1923, **10**, 11)
Specifications for raw tung oil according to the American Society for Testing Materials	0·943/15·5°	1·515–1·520/25°	7 (Max.)	190–195	163	12	Jamieson (*loc. cit.*)

It will be seen that the oils of *A. fordii* and *A. montana* are very similar and the constants of *A. montana* fall just a little outside the specifications for tung oil.

The press-cake contains a substance similar to toxalbumin and is poisonous. It is fairly rich in proteins (15–20%), and can be used as fertilizer (*Bull. imp. Inst., Lond.*, 1930, **28**, 270).

Tung oil has been used in China since remote times for the caulking of boats and junks, for the painting of woodwork, and, in admixture with natural resins, for the preparation of varnishes. The Chinese have also used tung oil for water proofing wood, paper and fabrics. Since its introduction into America and Europe early in the present century, the demand for this oil has steadily increased because of its special properties. It is at present extensively used, after suitable treatment, in the manufacture of paints, enamels, lacquers, etc. The oil shows considerable affinity for rosin, rosin esters and several synthetic resins, and in combination with these, it is used in the manufacture of varnishes.

Tung oil has become an important raw material in the linoleum and waterproofing industry. More recently, tung oil has been used extensively in the manufacture of electrical insulating varnishes, and in the treatment of aeroplane fabrics and in the automobile industry (brake linings).

Tung oil can be polymerised to a rubber-like material which also finds application in paints and varnishes. The oil, when burnt in an insufficient supply of air, yields carbon black, an ingredient of Indian ink or Chinese ink.

A. montana E. H. Wils. WOOD-OIL TREE

D. E. P., I, 162; C. P., 46; Pl. XII, 1.

A much-branched partially deciduous tree of moderate height (25–30′) with cordate leaves and monoecious flowers. The fruit is egg-shaped, $1\frac{3}{4}$–2″ long and $1\frac{1}{2}$–$1\frac{3}{4}$″ broad, pointed at the summit and flattened at the base. It has generally 3, and sometimes 4, one-seeded segments. The outer surface has wavy transverse ridges. The pericarp is thick, hard and woody.

A. montana occurs in the sub-tropical parts of southern China and in some of the Southern Shan States (Burma). Like *A. fordii*, this is also a hill-side species, but it can thrive in warmer climates and withstand heavier rainfall, provided the area is well drained. Its growth is vigorous in slightly acidic soil.

Experimental cultivation in different parts of India and Burma has shown that this species is better suited to the climatic and soil conditions of these countries than *A. fordii*. It has done very well in the alluvial soil of Assam. A rainfall varying from 70–110 inches, and a maximum temperature

of 96°F. and a minimum of 43°F. have not proved unfavourable to its growth. It has done equally well in Mysore at an elevation 2,500–3,000′ and an annual rainfall of 60 inches. It is frost-tender. In northern Burma, it has been observed to be more vigorous and disease-resistant than *A. fordii*. This species has also been successfully planted in Indo-China where it has replaced *A. fordii* and where the oil is now being produced on a commercial scale (*Bull. imp. Inst., Lond.*, 1939, **37**, 32).

Methods of propagation and cultural operations are similar to those of *A. fordii*. It is also not very exacting in its soil requirements, but there is no doubt that in richer soils the growth is more vigorous.

A. montana is reported to give a much better yield of fruits than *A. fordii*. The percentage of kernels in the seeds is about 56, and of oil in the kernels, about 59·3. The constants of the oil have been given along with those of *A. fordii* oil. Simonsen *et al.* (*Indian For. Rec.*, *loc. cit.*) examining the oil of *A. montana* grown in Burma, found it to consist chiefly of the glycerides of β-elaeostearic and oleic acids and probably a little linoleic acid.

THE OIL

Pure *A. montana* oil is not at present a commercial product. It has properties similar to those of the oil of *A. fordii*. It has a slightly lower refractive index, lower iodine value, and takes a little longer time for gelation in the heat test. These indicate a somewhat lower elaeostearic acid content, which is not necessarily a disadvantage in the varnish industry.

Varnish making trials that have been conducted at the Imperial Institute have shown that the products made from *A. montana* oil possess a high degree of water-resistance, gloss and durability, as are usually found in products from commercial tung oil. Since this species has been found more suitable for cultivation in the warmer countries and plantations have already been started and increasing quantities of pure *A. montana* oil will be coming to the market, it is necessary that separate specifications for this oil should be laid down and the oil sold on its own merits. If this is not done, the producers will be at a disadvantage (Jordan, *J. Soc. chem. Ind., Lond.*, 1934, **53**, 21 T).

A. moluccana (Linn.) Willd. THE CANDLE NUT TREE

D. E. P., I, 163 ; C. P., 47 ; Fl. Br. Ind., V, 384 ; Kirt. & Basu, Pl. 869.

Indian names are derived from *Jungli akrot* ; Wild walnut.

A handsome evergreen tree, about 60′ high, native to the Indo-Malayan region, but now widely distributed throughout the tropics. It is found wild in south India (Wynaad), Assam and Burma and is grown in some parts, but it is not abundant anywhere. The fruits are ovoid, about 2″ in diameter, with a hard husk enclosing one or two seeds or nuts resembling walnut.

The oil is extracted on a large scale in China and in the Philippines, but it does not appear to be expressed anywhere in India. Heating and suddenly chilling the fruits, or boiling them with water for 5 6 hours facilitates the removal of the husk (see also Brown, II, 126). The kernels constitute 30 % of the nuts and yield about 60% of a dark oil with the following constants :

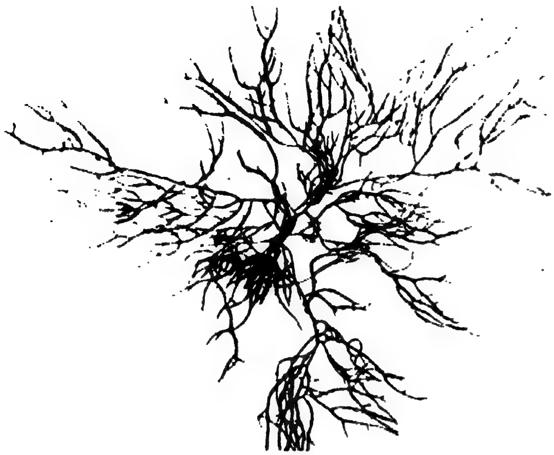
Source of oil	Sp. gr. 15°/15°	Acid val.	Sap. val.	Iod. val.	Reference
Hong Kong	0·927	1·72	204·2	139·7	*Bull. imp. Inst. Lond.*, 1907, **5**, 136.
India	0·9202	3·8	227·0	152	*Indian For. Rec.*, 1923, **10**, (ii) 11.

The oil dries quickly and consists chiefly of the glycerides of linolinic and linolic and oleic acids.

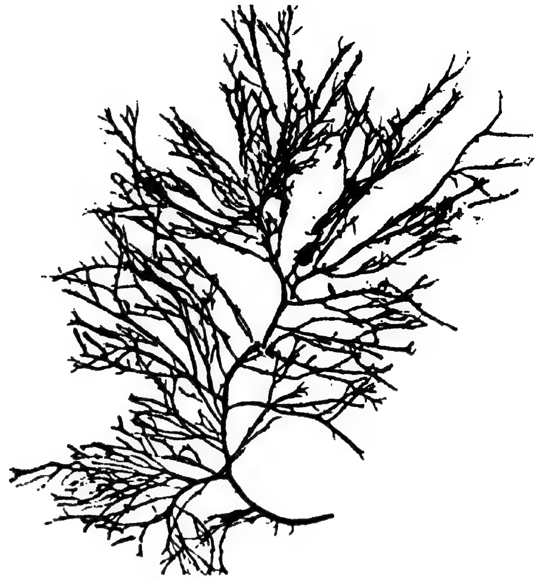
The oilcake (protein, 46·16 ; P_2O_5, 4·39 ; and K_2O, 1·95%. Brown, 132) cannot be used as a cattle food as it is poisonous. However, it is used as a fertiliser.

The oil finds use in the paint and varnish industry. In the Philippines and Java, it is chiefly employed for soap-making and for painting boats and craft.

Burkill (I, 92) gives an account of the several uses to which the plant is put. The oil is purgative, a dose of 1–2 oz. being usually employed. This property is attributed to a toxalbumin. The kernel itself is sometimes used as laxative. In Java, the seeds are said to be eaten after roasting, but it is dangerous to eat them raw. Candles shaped from a paste of the kernels are said to be used for illumination. Hence the common name of the tree in English.

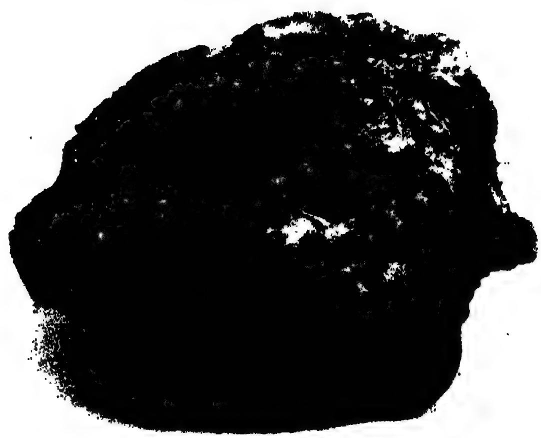


1. GRACILARIA CONFERVOIDES (ALGAE)



2. GRACILARIA LICHENOIDES (ALGAE)

3. MEDICINAL ALOE (Bangalore)



4. AMORPHOPHALLUS CAMPANULATUS

The bark is reported to contain tannin. The wood is light and is reported to be good for match sticks and as raw material for paper pulp (*Bull. imp. Inst. Lond.*, 1928, **26**, 95).

Alfalfa or **Lucerne**, **Medicago sativa**

ALGAE

Algae are simple autophytic plants the majority of which are aquatic. They are usually differentiated by their colours: green, blue-green, brown or red. Some species of marine algae are of economic value. They do not grow deep in water and are confined to a narrow belt not more than a few hundred yards from the shore.

Some species of blue-green algae (*Aulosira fertilissima* Rao, *Anabaena* spp. etc.) commonly growing in Indian rice fields, which are water-logged during the rains, are reported to be responsible for the fixation of nitrogen, thereby maintaining the fertility of the soil (Singh, *Indian J. agric. Sci.*, 1942, **12**, 743; De, *Proc. roy. Soc.*, B, 1939, **127**, 121).

MARINE ALGAE

Several marine algae of economic importance including *Gelidium* and *Gracilaria* occur on the Indian coasts (Boergesen, *J. Indian bot. Soc.*, 1937, **16**, 1 & 311; 1938, **17**, 205; Biswas, *J. Bombay. nat. Hist. Soc.*, 1945, **45**, 515). *Gelidium corneum* (Huds.) Lamour. and *Gracilaria confervoides* (Linn.) Grev. are fairly abundant, and *Gracilaria lichenoides* (Linn.) Harv., less so (Pl. XI, 1 & 2). The two latter are reported to occur in nearly equal proportion in the Chilka lake. The occurrence of *Rhodymenia dissecta* Boergesen and *Porphyra tenera* Kjelln., related to the edible species of Japan, is also reported. *Ulva lactuca* (Linn.) Le Jolis, an edible green algae is also very common.

Several species, e.g., *Porphyra vulgaris* Ag. *Gelidium corneum*, etc., are used as food in Japan and China, and the former is also cultivated in Japan. Similarly *Chondrus crispus* Lyngb. (Irish amoss), *Laminaria saccharina* (Linn.) Lamour. and *Rhodymenia palmata* (Linn.) Grev. are eaten in Ireland, Scotland and America. A few of the algae belonging to the genera *Gelidium*, *Gracilaria* and *Ulva*, occurring on the coasts of India and Ceylon, are also edible. A thick coarse species of *Spirogyra*, (genus of green fresh-water algae), is reported to be eaten in the Northern Shan States.

The food value of algae, however, is low. Their carbohydrates, chiefly galactans, mannans, pentosans, etc., are not easily digested by gastric enzymes. Most species do not contain cellulose, and starch is found only in a few. Several of them are poor in proteins and fat.

The algae are also not of much value as fodder. They are neither liked by cattle nor are they easily digested. They are used as manure, particularly in areas where large quantities become available as drift-weed. They supply mainly potash and a small amount of nitrogen; and the organic matter in them increases the humus content of the soil.

Some algae are used in the treatment of glandular afflictions on account of their iodine content. *Chondrus crispus* is considered a specific for intestinal and bronchial ailments.

The burning of sea-weed for the recovery of potash and iodine is an old industry in Scotland, Norway, France and Japan.

COMPOSITION OF EDIBLE ALGAE*

(Per cent. of air-dry weeds)

	Water	Crude protein	Fat	Carbohydrates		Ash
				Sugar, starch, etc.	Crude fibre	
Chondrus crispus	18·8	9·4	..	55·4	2·2	14·2
Porphyra vulgaris	14·0–21·9	25·7–36·3	0·2–1·[illegible]	33·3 43·3		8·8–14·6
Laminaria angustata Kjelln.	22·8	5·5	1·[illegible]	46·9	4·6	18.7
Ulva fasciata Delile & *U. lactuca*	18·7	14·9	0·04	50·7	0·2	15·6

*Tressler, 112.

COMPOSITION OF DRY SEA-WEEDS USED FOR KELP*

(Per cent. of air-dry weeds)

	Water-soluble ash	Potash	Iodine
Laminarias	16·9—28·6	4·5—11·9	0·3 —0·55
Fucus .	15·6—16·2	2·6 — 3·8	0·034—0·086

*Tressler, 74.

Dixit (*J. Indian chem. Soc.*, 1930, **7**, 959), has found that certain species of ***Fucus*** and ***Sargassum*** occurring on the West Coast contain 0·03-0·05 per cent. of iodine (air-dry weeds).

For the recovery of iodine and potassium salts, the ash of sea-weeds (or kelp) is lixiviated and the aqueous solution filtered and concentrated. The potassium and sodium salts are removed and separated by fractional crystallization. To obtain iodine the mother liquor is concentrated and distilled with strong sulphuric acid and manganese dioxide. Iodine is also precipitated from the mother liquors by chlorine, or as cuprous iodide. Iodine is now mostly obtained as a by-product of the Chilean nitrate industry, and sea-weeds contribute only about 25% towards world's annual production.

AGAR-AGAR

The dried aqueous extract of some species of red algae (***Rhodophyceae***) is known agar-agaras or agar. It comes into the market in the form of translucent sheets, rectangular blocks, flakes, sheaves of ribbons, and also as powder. Commercial agar-agar varies in colour from yellow to pink or black. The best qualities are nearly colourless. Agar-agar is insoluble in cold water, but swells up considerably and becomes a stiff gel retaining its original form. However, it dissolves when boiled with water. A one per cent. solution forms a stiff gel when cooled to room temperature, and the gel is reversible.

The chief carbohydrate in agar-agar is a galactan. This is esterified by one of the two acid groups of sulphuric acid, the second forming a calcium salt (Robertson, *Industr. Engng. Chem.*, 1930, **22**, 1074). Agar-agar is partially hydrolysed by mineral acids, when it loses its properties of gel-formation.

Agar-agar has long been used as food by the Chinese and the Japanese. It is eaten in the form of jellies and is used as a thickener for soups, sauces, etc. It is also used in Europe and in the U. S. A. in icecreams, jellies and jams. In recent times, it has found various industrial uses: as a sizing material, emulsifying agent, thickener in the dyeing and printing of textiles and in the finishing of leather. Agar-agar is a constituent of several high grade adhesives, and has been generally employed as a substitute for gelatine.

It is also used in medicine. Medicinal agar-agar should not yield more than 5% of ash (B. P.). It has little nutritive value and is mainly employed in laxatives. It is also used in dressing certain types of wounds, because of its inhibitory action on blood-clotting. Biscuits made from agar-agar and bran are given to diabetic patients.

The most important use of agar-agar is for the preparation of culture media in bacteriology. Its chief advantage is that, unlike gelatine, it is not liquified by many organisms. It forms a firm jelly without refrigeration. It remains a liquid when cooled to 40°, but once solidified, remains a gel at blood-heat (Newton, ***Endeavour***, 1945, **4**, 69). During the War, large quantities of agar-agar were required by medical and public health services.

For the preparation of agar-agar, the algae, after harvesting, are cleaned, washed with water, spread out in the sun and bleached by alternate drying and wetting. The dried weed is then repeatedly boiled with water till it is completely exhausted, or is charged with water into wooden tanks and steamed. After settling, the clarified solution, filtered if necessary, is siphoned into shallow frames and allowed to solidify. The blocks are then cut into smaller pieces and chilled to —5° to —15°. After freezing, they are again exposed to the sun. During thawing, water runs out leaving the material in a very porous state. It is then dried in the sun and graded for marketing.

In Japan, a small quantity of acetic acid or sulphuric acid is added towards the end of the boiling. This practice is said to facilitate extraction and to yield a clearer product. Commercial agar-agar is purified by washing it with dilute acetic acid and redissolving it in hot water. The hot liquors are also treated with charcoal and filtered under

pressure. In America, purification is effected by controlled refrigeration and dialysis (Newton, *loc. cit.*).

Before the last War most of the world's supply of agar-agar used to come from Japan. In 1936, Japan produced 2,549 tons valued at over 9½ million yen, and her exports were valued at 5½ million yen. The U. S. A. developed an agar-agar industry after the first World War and production in 1925 was about 360 tons. Since 1939 attempts have been made in various countries such as New Zealand, Australia, South Africa and Ceylon, to produce agar-agar and now Australia is reported to have a well-established industry (Newton, *loc. cit.*). During the last War, the *Gracilarias* occurring on the coasts of the Indian peninsula were used for the production of agar-agar and the Madras Medical Stores Depot produced 3–4 thousand pounds of agar-agar of B. P. quality (Govt. of India, Dep. Industr. and Supplies). It is proposed to increase production in India to 10 tons per annum.

COMPOSITION OF AGAR-AGAR

(Per cent.)

	Commercial agar-agar A	Indian agar-agar B	C
Moisture	16·6	12 13	16·6
Protein (N × 6·25)	2·3	..	1·1
Nitrogen free extract (chiefly gelose)	76·2	..	..
Ether extract	0·3	0·7	..
Ash	3·9	4·8	3·6

A, Tressler, 127; B, *J. sci. industr. Res.*, 1943, **I**, 98; C, *Curr. Sci.*, 1944, **13**, 99.

The principal species of sea-weeds used by the Japanese are *Gelidium corneum* Lamour., *Campylaephora hypnoides* J. Ag. and *Gracilaria confervoides* Grev. Japanese *Gelidium* yields 25–35 % of agar-agar (Armstrong & Miall, 114). These species are also found on the Californian coasts. *Gracilaria confervoides* is utilised in Australia. This algae as well as *Gracilaria lichenoides* occur on the coasts of Java, Malaya, Ceylon and India. The yield of agar-agar from Ceylon moss (*G. lichenoides*) and Chilka lake *Gracilaria* was 20–25 per cent.

Alginic acid or algin is an interesting technical product obtained from certain *Laminarias* (algin content, 33–40 per cent.) by extraction with sodium carbonate. The free acid is insoluble in water, but it swells like Karaya or tragacanth gums, absorbing large quantities of water. It is principally used as a stabiliser in food industries such as ice-cream manufacture. Solutions of sodium alginates have high viscosity. The salt is generally used for many purposes for which gums and pectins are employed, e.g., stabilisers, sizing materials, etc. Other metallic salts (calcium, aluminium, etc.) are used to waterproof fabrics. Solutions of sodium alginate dissolve shellac. The lacquer, when dried, gives a tough and tenacious film which is rendered insoluble by treatment with acids. Alginates can be frothed and made into very light boards (Armstrong and Miall, 116).

ALHAGI Adans. LEGUMINOSAE

This genus of thorny shrubs comprises about 3 species, distributed in the Mediterranean region and western Asia.

A. camelorum Fisch. = *A. pseudalhagi* (Bieb.) Desv.
Syn. *A. maurorum* Baker

CAMEL THORN, PERSIAN MANNA PLANT

D. E. P., I, 164; *Fl. Br. Ind.*, II, 145; Kirt. & Basu, Pl. 307.

PERS.—*Khar-i-shutr*; HIND.—*Jawasa*; MAR. & GUJ.—*Jawaso.*

A low, spreading spiny shrub, 2–3′ high, found in the drier parts of Gujarat, Sind, the Punjab, the United Provinces, Rajputana and Baluchistan.

The sugary secretion (manna) obtained from this plant is said to be collected in Persia and exported to India. It occurs in small round grains, which adhere to form an opaque mass, and has been found to consist mostly of sugar: melizitose, 47·1; sucrose, 26·4 and invert sugar, 11·6 per cent. (Ivanova, *Chem. Abstr.*, 1937, **31**, 3104). There is no record of Indian plants yielding this manna.

The manna is a mild laxative. An infusion of the plant is used in affections of the chest (Kanny Lall Dey, 17).

The plant is given as fodder to camels. The twigs are much used in making screens (tatties).

ALISMA Linn. ALISMACEAE

D. E. P., I, 166.

A small genus of marshy herbs of about 10 cosmopolitan species. Three species are commonly met with in India in marshes throughout the plains.

The tuberous rhizome of *A. plantago* Linn., Water Plantain (Bengal, Bihar, lower Himalayas from Kashmir to Manipur and Burma), is said to be edible.

ALKALINE SOILS AND LAKES

Crude natural soda : HIND.—*Reh, sajjimatti* ; *phuli* ; SIND.—*Chaniho, kallar, dalla* ; TEL.—*Soudu* ; KAN.—*Choulu.*

Crude natural sodium sulphate : HIND.— *Khari* ; JODHPUR—*Rohr.*

Alkaline salts have been obtained since very early times from *reh* soils (soils containing alkaline efflorescences), and alkaline lakes in India, but it is only in recent years that systematic surveys have been undertaken. Cotter published a detailed account of the alkaline lakes of Sind and the adjoining areas (*Mem. geol. Surv. India*, 1923, **47**, 202) and Auden, Gupta, Roy, and Hussain have surveyed the *reh* efflorescences of the U. P. (*Rec. geol. Surv. India*, 1942, **77**, *Prof. Paper*, No. 1).

ALKALINE SOILS

Reh (D. E. P., VI, 1, 401 ; C. P., 51) is essentially a mixture of sodium carbonate, sodium sulphate and sodium chloride. These salts result from the decomposition of the particles of minerals such as plagioclase felspar, present in the alluvium. They are found, in varying quantities, in sub-soil water, but it is only in certain regions that as a result of defective drainage and excessive evaporation, they are brought up by capillary action and become concentrated at the surface. *Reh* occurs extensively in parts of the Punjab, Rajputana, Sind, Baluchistan, Bihar and the U. P. Similar deposits have also been recorded from Bombay, Kathiawar, Mysore and Berar. *Reh* encrustations render land totally unfit for cultivation.

Alkaline soils are characteristic of regions, where desert conditions prevail. Even in areas where rainfall is considerable, climatic conditions favourable to the formation of *reh* salts may be produced if a long dry season intervenes. According to Auden *et al.*, the high water table in the U. P. and Bihar is one of the chief causes of *reh* formation, since it brings the capillary fringe of ground-water within the influence of surface evaporation.

Some *reh* deposits are composed essentially of sodium carbonate and sodium sulphate with minute traces of sodium chloride, while others contain a much larger proportion of sodium chloride. The latter type of efflorescence occurs in the drier zones of the Punjab, Rajputana and Bombay.

DISTRIBUTION

Baluchistan : *Reh* encrustations have been recorded in certain localities in the Saindak area (Chaghai dist.). Analyses of salt from these areas showed considerable variations (SO_4, 7·99–36·44 ; HCO_3, 0·16–0·31% ; and CO_2, nil).

Bihar : Sodium sulphate occurs in Champaran, Muzaffarpur and Saran dists. Small deposits also occur in Gaya and Monghyr dists. In Champaran dist. *reh* is sparsely distributed in the Bettia and Sadar subdivisions (estimated yield, 370 tons per annum). *Khari*, the crude sulphate, is found in almost all the villages of Pipra and Kesariya thanas. Annual production of the salt (SO_4, 38·95 ; HCO_3, 0·38 %) is estimated to be 700 tons.

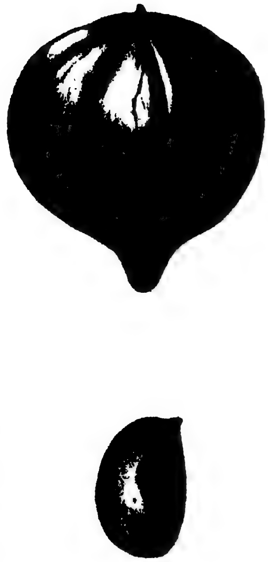
Recently, Gupta, B. C. and Gupta, D. (1945), have reported the occurrence of certain *reh* soils in Saran dist. (Gopalganj, Sewan and Chapra subdivisions). These are estimated to yield annually 1,250 tons of *reh*. The most notable occurrence of *khari* soil (SO_4, 13·21%) in this district is in the Gopalganj subdivision. This area is capable of producing annually 3,700 tons of the crude salt (SO_4, 45·3%).

The average annual production of *khari* in Bihar during 1908–23 was 14,850 tons, valued at about 3·5 lakhs of rupees.

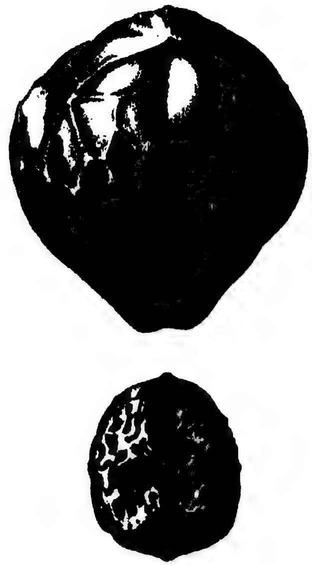
Bombay and Gujarat : *Reh* occurrences have been recorded by Ghosh (*Rec. geol. Surv. India*, 1942, **77**, 242) one mile north of Parantij town (23°26′ : 72°54′) along the banks of the Khari river. Analyses show considerable variations in the percentages of sodium salts (NaCl, 2·84–15·81 ; Na_2SO_4, 2·29–3·87 ; Na_2CO_3, 8·96–53·59%). These deposits are used locally in the manufacture of soap.

Burma : Soap-sand or *sapaya* is an impure efflorescent alkaline deposit, which occurs mainly in the Tertiary rocks of the Dry Zone. It consists of sodium salts including the carbonate, with a large amount of intermixed sand, and is exploited to some

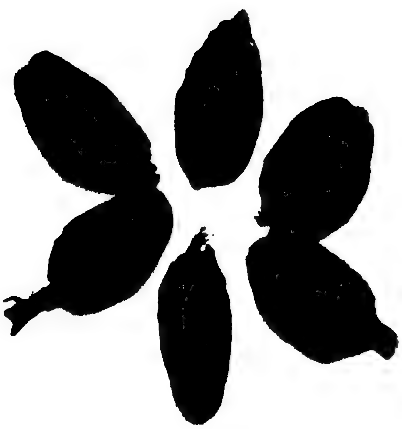
1. ALEURITES MONTANA



2. FRUITS OF ALEURITES FORDII



3. FRUITS OF ALEURITES MONTANA



4. GREATER CARDAMOM
(AMOMUM SUBULATUM)

5. LESSER CARDAMOM
(ELETTARIA CARDAMOMUM)

extent for local use in Sagaing and other districts of the Dry Zone. Its main uses are for cleaning and washing utensils and laundering clothes. Alkaline salts are also obtained from springs in Myitkyina, Shwebo and Lower Chindwin dists.

Hyderabad : Alkaline earth, consisting essentially of sodium sulphate with some sodium carbonate, is known locally as *khar neemak*. It occurs in the form of a light white powdery encrustation, in parts of Makhtal taluk near Satyawaram, Khanapur, Kadmur, Raicod, Mantangod and Sodampalli, and in parts of Yadgir taluk. Soda ash used to be recovered from *khar neemak* for use in the glass works at Manikonda and Gazulpet (*J. Hyderabad geol. Surv.*, 1941, **4**, i, 78).

Kathiawar : Considerable areas covered by *reh* encrustations have recently been observed in the dry parts and the coastal region of Kathiawar. The occurrence of several *reh* encrustations along the coastal belt of southern Kathiawar between Kodihar (20° 47′ : 70° 44′) and Bherai (20° 58′ : 70° 8′) has been recently reported by Krishnaswamy.

Mysore : *Reh* soils occur in Mysore, Mandya, Tumkur and Chitaldrug dists. It is noteworthy that these efflorescences occur on soils derived from granites and gneisses. Usually 3–4 crops of *reh* are obtained between January and April and the salt is locally used by washermen for laundering clothes.

Recent investigations have shown that Dodmole deposits near Chamarajnagar (Mysore dist.) are capable of yielding 35–40 tons of soda per annum (*Rec. geol. Dep. Mysore*, 1943, **42**, 35).

United Provinces : In 1922, Watson and Mukherjee (*J. Indian Industr.*, 1922, **2**, 13) estimated that about 1,870 square miles of the U. P. were covered by *reh*. But according to Auden *et al.*, the *reh* producing area is confined at the most to 100 square miles with an estimated annual yield of 540,900 tons of Na_2CO_3, 556,300 tons of $NaHCO_3$, and 307,300 tons of Na_2SO_4.

In Meerut dist., *reh* occurrences are reported near Panchlikhurd (28° 58′ : 77° 36′) and around Puthhas (29° 2′ : 77° 35′), and between Harra (29° 7′ : 77° 29′) and Nandpura (28° 59′ : 77° 29′) along the eastern bank of the Hindan river. Further an important *reh* tract is found in Loni pargana (Ghaziabad *tahsil*) between Pali Sadikpur (29° 47′: 77° 17′) and Dehroti (28° 43′ : 77° 6′) along the eastern bank of the Jumna, and Auden estimates that this covers nearly 2 million square yards with an estimated annual yield of 7,671 tons of *reh*.

In Moradabad dist. considerable areas of *reh* efflorescences stretching along the river Ganges have been reported from Hasanpur *tahsil*. One of these is a stretch, 7 miles long on the eastern bank of the river, opposite Garhmuktesar (28° 47′ : 78° 6′). Another area lies between Kankather station (28° 48′ : 78° 11′) and Tigri (28° 49′ : 78° 9′), and a third between Kankather and Matena (28° 43′ : 78° 13′). The encrustation occurs in the form of patches of loose dust, often 2–3″ thick. Production from different patches varies from 5–30 lb. per square yard. The thickest encrustation in the area occurs in a locality, intermediate between Rakhera (28° 45′ : 78° 12′) and Diaoli (28° 44′ : 78° 12′), yielding 50 lb. of *reh* per square yard. *Reh* from these localities is mostly sent to Moradabad, Bijnor and Rampur.

ANALYSES OF *REH*

(Per cent.)

	Na_2CO_3	$NaHCO_3$	NaCl	Na_2SO_4
Meerut dist.	3·81	4·12	3·25	1·70
Moradabad dist.	9·66	8·55	1·92	8·66

Considerable deposits of *reh* have been reported to occur S. and SSW. of Lhaksar station in Muzaffarnagar dist. About 2,000 tons of *sajji matti* (*reh* with a high proportion of carbonates) used to be sent annually to Calcutta from Benares, Azamgarh, Jaunpur and Ghazipur (*Rec. geol. Surv. India*, 1930, **64**, 432).

Reh is recovered from soils by lixiviation and is used in the manufacture of crude glass and soap. It is also used for curing hides and skins and in tanning leather. *Dhobis* employ it for laundering, and the poorer classes use it for cleaning cooking utensils.

ALKALINE LAKES

The principal alkaline lakes of India are in Sind and Rajputana. Cotter has listed close upon 248 lakes in Sind (*vide* also Dubey and Shukla, *Quart. J. geol. Soc. India*, 1942, **14**, 125), but only a small number of these are productive. The Lonar lake in Berar, and the bitterns from the brine wells at Kharaghoda (Ahmedabad dist., Bombay), and

the salt works at Kuda (Dhrangadhra State), and at Mauripur near Karachi, are some of the other sources of alkaline salts. Of these, at present, only a small portion of Kharaghoda bitterns is being exploited.

The alkali carbonates found in the lakes are believed to have been formed by chemical reactions between salt and gypsum, and calcium bicarbonate. The first two give rise to calcium chloride and sodium sulphate, and sodium carbonate is formed from sodium sulphate and calcium bicarbonate. Another view is that sodium sulphate is reduced by organic matter such as algae, and converted into alkali carbonate by the action of carbon dioxide derived by bacterial action. In Sind, the geological conditions according to Cotter, favour the latter hypothesis.

DISTRIBUTION

Berar : The Lonar lake (19° 58′ : 76° 34′) is an enormous circular depression situated in the Deccan Trap in Buldana dist. This lake has been regarded as the crater of an extinct volcano, or as a big natural depression due to subsidence (LaTouche, *Rec. geol. Surv. India*, 1912, **41**, 266) ; and its alkali salts are derived from the disintegration of igneous rock. But the small proportion of chlorine in the trap does not lend support to this view (cf. Christie, *ibid.*, 276).

In 1910, this lake was estimated to contain about 2,000 tons of sodium carbonate, and about 4,500 tons in the upper 5′ of mud. A small amount of crude soda called *dalla* (about 40 tons in 1931), of the approximate composition of urao, $Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$, has been produced from the waters of the lake by crude fractional crystallisation.

Rajputana : The Sambhar lake (26° 55′ : 75° 11′ situated in Jaipur and Jodhpur states is a potential source of large quantities of sodium carbonate and sodium sulphate. The bitterns obtained during the manufacture of common salt contain a comparatively high concentration of sodium salts ($NaCl$, 19·8 ; Na_2SO_4, 6·9 ; Na_2CO_3, 3·8%). They are pumped into reserved areas, the largest of which is the East Lake Bitterns area, covering approximately three square miles.

The saline deposit formed is about 1′ in thickness and eight layers may be distinguished (A–H). Of these, the topmost (H) and the lowest (A) layers are very thin and consist of pure sodium chloride. The following is the percentage composition of layers B–G :

	B	C	D	E	F	G	Weighted average of salts in layers B–F
Mean thickness in inches	2¼	2¾	⅛	2½	½	3½	
$NaCl$	18·8	11·8	100	35·1	61·4	100	28·6
Na_2SO_4	64·2	21·6	..	49·6	33·6	..	40·5
Na_2CO_3	10·6	32·0	..	4·5	..	..	14·5
$NaHCO_3$	4·3	22·0	..	2·8	..	..	9·1

Auden estimates that the quantity of Na_2SO_4 present is about 1·7 million tons. The bed of the lake up to a depth of 12′ is further estimated to contain 5·8 million tons of sodium sulphate and 2·3 million tons of sodium carbonate.

The annual production of common salt from Sambhar lake is about 200,000 tons. From the bitterns obtained, 20,000 tons of sodium sulphate can be recovered.

Dunnicliff (*Curr. Sci.*, 1943, **12**, 7) has drawn attention to the occurrence of sodium sulphate in Didwana lake (27° 23′ : 74° 35′), Jodhpur State, which covers an area of about 4 square miles. The crystallised salts left after the complete evaporation of bitterns contain a considerable percentage of sodium sulphate ($NaCl$, 2·45 ; Na_2SO_4, 87·5%). It has been estimated by Saha (ex Auden, *et al.*, *loc. cit.*) that for every 100 tons of common salt prepared from the lake, 25 tons of the sulphate (85–90%) could be obtained, yielding annually some 9,000 tons of the sulphate.

According to the Director of Industries and Commerce, Jodhpur Government, the following are the quantities of sodium sulphate (in tons) produced from Didwana and sold to different industries :

	'42-43	'43-44	44-45
Production	9,065	3,688	5,485
Consumption :			
Paper mills	3,580	2,470	2,540·0
Chemical industries	832	1,270	3,945·0
Glassworks	61	30	154·5
Misc. industries	706	1,190	285·0
Total	5,179	4,960	3,374·0

The material (85 90%) was sold at Rs. 95 per ton f. o. r. Marwar Balia.

Pachbadra Salt Basin : The sub-soil brine of the salt basin of Pachbhadra (25° 50′ : 72° 10′) in Jodhpur State contains big reserves of sodium sulphate. It is reported that impure salt from this area contains : NaCl, 25, and Na_2SO_4, 67%.

Sind : The major alkali producing lakes of Sind are found in Khairpur State, to the east and west of Nara region, and in the Kot Jubo region. The lakes of Nasarat taluk of Nawabshah dist., and Thar and Parkar dist. are of minor importance.

In the desert regions of Sind, a fair proportion of rain water percolates through sandy layers and finally rests upon the impervious bed of clay, which forms the basal portion of the desert. In these areas, hollows or *talis* occur frequently and expose the basal layers. The percolating waters, emerging along their margins in the form of springs, fill them to form lakes, locally known as *dhands*. These are as a rule comparatively shallow and vary considerably in size. Some *dhands* are fairly large in area. The percolating waters dissolve the salts in the soil and carry them to the *dhands*.

In these regions, during the dry season, evaporation is considerable and results in the concentration of salts. The productivity of the lakes depends on rainfall and percolation and varies with changes in drainage. Marked variations have resulted also from the canalisation of certain regions, or because of factors, which have retarded percolation. Owing to the canalisation of the Nara river, the *dhands* of some areas of the Thar and Parkar region have become dry and unproductive. On the other hand, following a year of heavy rainfall, several *dhands* in the Kot Jubo region, which were completely dry at one stage, became productive. Excessive rainfall sometime dilutes the *dhands* to such an extent as to make them unproductive.

The composition of Sind lake brines shows considerable variation. Usually lakes situated away from the sandy plateaux, *dra-ins*, show a preponderance of salt over soda, compared to those occurring in the middle of *dra-ins*. Lakes in the Nara region contain the sulphate, the carbonate and the chloride, whereas the Kot Jubo *dhands* contain mostly the carbonate and the chloride, with very little of the sulphate. *Dhands* of medium size and depth which never dry up completely, yield purer salts than those which dry up.

Cotter gives the following analyses of Sind lake bitterns and of efflorescences found round the lakes :

BITTERNS

(G. per l.)

Name of *dhand*	Sp. gr.	Total solids	Na_2CO_3	Na_2SO_4	NaCl
Sukchaho, west of Nara	1·164	202·0	111·6	26·3	65·8
Mithri, west of Nara	1·265	..	124·0	55·3	148·7
Lambro, east of Nara	1·081	103·74	13·3	37·2	48·3
Pakhyaro, Kot Jubo area	1·104	113·1	74·2	4·0	22·6

EFFLORESCENCES

(Per cent.)

Name of *dhand*	Na_2CO_3	$NaHCO_3$	NaCl	Na_2SO_4
Mithri, west of Nara	27·0	12·8	35·4	15·7
Ashrafwaro, east of Nara	22·8	17·2	2·9	7·5
Kandiwaro, Kot Jubo area	27·0	18·5	9·7	3·7
Ridhwari, Nawabshah dist.	18·0	14·9	8·5	14·8
Khari, Thar and Parkar dist.	30·2	15·6	12·7	21·0

The crude salt obtained by the desiccation of lakes is known as *chaniho*, but the local people do not distinguish between the carbonates and sulphate of soda. In the absence of heavy rains in July, two crops of *chaniho* are obtained, the first during May-June, and the second during September-October. Extraction is simple and the salts are removed by shovels, as soon as a sufficiently thick crust is formed by desiccation. If rains are heavy, the second crop fails owing to the dilution of the *dhand* waters. To prevent this, low bunds are built.

Production of *chaniho* from most of the lakes is small and irregular. Production from Nawabshah dist. averaged 112 tons during the quinquennium ending '33-34. According to Khan Bahadur Colabwala, Chief Engineer, Khairpur State, 32 saline lakes in Tappa Adlahu, and 29 saline lakes in Tappa Jubo, both in Nara taluk, were in production during '39-43. The average annual production of the first area was about 1,370 tons, and of the second, 311 tons. The larger producing lakes were in Chhuchh (500), Bharki (338), Debhan wari (290), and Jhamer (290). The figures in brackets indicate the maximum production in tons in a peak year.

Chaniho has approximately the composition of urao and it is used for washing clothes, hardening treacle, and in soap making. It is also reported to be used in the preparation of light biscuits and in curing country tobacco. It is mostly exported from Karachi to Arabia, Bombay and Aden (*Rec. geol. Surv. India*, 1936, **20**, 439).

Sodium sulphate and sodium carbonate are the two main products which can be obtained from alkaline lakes and soils. The bitterns of Sambhar and Didwana lakes form a valuable source of the former. In India, the extraction of pure carbonates from natural sources has not so far proved economical.

ALLAEANTHUS Thw. MORACEAE

D. E. P., I, 168.

A small genus of deciduous trees with milky sap, including 3 species, met with in the Indo-Malayan region.

According to Watt, a very tough fibre is obtained from the inner bark of *A. zeylanicus* Thw., a species confined to Ceylon.

ALLAMANDA Linn. APOCYNACEAE

D. E. P., I, 167.

A small genus of climbing shrubs, comprising about 12 species, distributed in tropical America. *A. cathartica* Linn., a woody climber with large bright yellow flowers, and a few other species are cultivated in Indian gardens for their showy flowers. The leaves of *A. cathartica* possess valuable cathartic properties (Burkill, I, 98).

ALLIUM Linn. LILIACEAE

A genus of bulbous herbs, with characteristic odour, comprising 250–300 species, mostly indigenous to northern temperate regions. About 27 species are reported from India, of which *A. cepa* (onion), *A. sativum* (garlic), and *A. porrum* (leek) are well known vegetables. Garlic and a few other species have their medicinal uses, while some (e.g. *A. fragrans* Vent.) are ornamental.

A. ascalonicum Linn. THE SHALLOT

D. E. P., I, 168; C. P., 58 Fl. Br. Ind., VI, 337; Kirt. & Basu, Pl. 972.

HIND. *Gandana*; BENG.—*Gundhun*.

The shallot is a native of Palestine and is cultivated in Indian gardens for its bulbs and green leaves. It is propagated both by seeds and by bulbs. Clusters of greenish white or red cloves occur at the base of its hollow cylindrical leaves. The cloves and green leaves are used for flavouring curries and for pickling.

A variety of shallot, smaller and with a larger number of cloves, is exported to Ceylon and Malaya from Madras.

A. cepa Linn. ONION

D. E. P., I, 169; C. P., 58; Fl. Br. Ind., VI, 337.

SANS.—*Palandu*; ARAB.—*Basl*; PERS. & HIND.—*Piyaz*; BENG.—*Pyanj*; MAR.—*Kanda*; GUJ.—*Dungari*; TEL.—*Nirulli, ulligaddalu*; TAM.—*Vengayam*; KAN.—*Nirulli, irulli*; MAL.—*Chuvannaulli*.

The plant is a bulbous, biennial herb, bearing linear, hollow, fleshy, cylindrical leaves and umbels of small white flowers. The flowers mature into 3-celled capsular fruits containing small, black seeds. The flower-heads also sometimes bear bulbils. The underground bulbs, which constitute

the crop, vary in size, colour (white, yellow, red, brown), shape (round, flat, conical), firmness, keeping quality, period of maturity and strength of flavour.

The onion is extensively cultivated in India. It is both a field crop and a garden crop. Being an irrigated crop of short duration, the onion can be grown as a catch-crop in the midst of crops like sugar-cane and turmeric, and can be rotated with rice, coriander, and garlic. Delicate imported varieties are grown in gardens as winter vegetable.

Onion is grown from seeds, bulbs or bulbils. In certain areas where seedlings are liable to be swept away by rain, bulbs are preferred. It requires a dry climate and grows best in a light manured soil, a rich sandy loam being the most suitable. Thorough ploughing before planting, and copious fortnightly irrigation of the crop will give a good yield and prevent the formation of 'doubles'. Finely powdered fish manure, sulphates of ammonia and potash, nitrate of soda and superphosphate are among the fertilizers that greatly improve the yield.

In south India and Bengal, the bulbs are planted about the end of the monsoon and the planting is continued until early hot weather. They are planted at the rate of 750–1,000 lb. per acre with a 4–5″ spacing, in a well prepared, manured soil, laid out in narrow strips, or furrows and ridges of 9″ width. In the north, the crop is usually grown from seeds sown broadcast during August–November in the plains, and February–June on the hills, on raised beds in shallow drills at the rate of about 15 lb. per acre. Transplanting gives better results. The seedlings when 2–3″ high, are transferred to irrigated beds. About 8–10 lb. of seeds can raise sufficient seedlings for an acre.

In India, the seeds do not keep for more than one season. The seeds are raised from bulbs planted in rows 1–1½′ apart at the beginning of the cold season (Oct.–Nov.). Only healthy well shaped bulbs are selected for planting. Sometimes only the lower half is planted, the upper half being used for edible purposes. This ensures strong flower shoots. Early flowers produce heavier and more vigorous seeds than late flowers. The seed-crop is raised in small areas and about 800–1,000 lb. of seeds are obtained per acre.

When the bulbs are nearly full grown, a twist and slight beating down of the foliage, without breaking it, assists in the swelling of the bulbs. The bulbs are ready to be taken out when the leaves are completely withered. The crop is harvested in about 90 days with an approximate yield of 7,000–15,000 lb. per acre, depending on the type of soil and manuring. When raised from bulbs, the yield is about 15,000 lb. per acre. Before being stored, the harvested onion is dried and cured to develop its characteristic flavour.

In India, the onion is comparatively free from major pests of any kind. *Alternaria palundii* Ayyangar, *Aspergillus niger* Van Tiegh, *Erysiphe taurica* Lev. and *Puccinia porri* (Sow.) Wint., etc., are the fungi reported to be found on onions. The burning of dead tops, a proper rotation and dusting with flowers of sulphur check fungal attacks.

Thrips (*Thrips tabaci* Linn.) which suck the sap by feeding on the foliage, can be controlled by the spraying of tobacco decoction, or by dusting with a mixture of crude napthalene and hydrated lime (80 : 120). A leaf-eating caterpillar (*Laphygma exigua* Hb.) is sometimes found attacking the crop. It is hand picked and destroyed.

The best acclimatised strains in India are the Patna onions ('Silver skin') and the 'Common' or 'Large red' onions ('Red skin'). A Bombay variety, from Janjira, is a much prized type. Pickling onions are a smaller variety. The white-skinned varieties are mild and of good flavour. The red varieties are more pungent but keep better owing to the presence of catechol and protocatechuic acid in the skin (*J. biol. Chem.*, 1933, **100**, 379). Ailsa Craig, Spanish Bermuda, Suttons A-1, Tripoli, etc., are some of the foreign varieties grown in gardens.

The onion is popular as a vegetable and is also used for flavouring and pickling. It is also considered a valuable winter food for cattle and poultry.

Onion (big) contains: moisture, 86·8; protein, 1·2; fat, <0·1; carbohydrates, 11·6; Ca, 0·18; P, 0·05%; Fe, 0·7 mg.; vitamin A, 25 I. U.; vitamin B_1, 40 I.U.; and vitamin C, 11 mg./100g. (*Hlth. Bull.*, No. 23, 1941, 31). The bulbs and fresh herb yield 0·005% of an essential oil ($d/9°$, 1·041; $[\alpha]_D$, $-5°$) which has an acrid taste and unpleasant odour. The chief constituent of the crude oil is

allyl-propyl disulphide $C_6H_{12}S_2$ (Platenius, *J. agric. Res.*, 1935, **5**, 847).

The onion is said to possess stimulant, diuretic and expectorant properties, and is considered useful in flatulence and dysentery. Freshly expressed onion juice has moderate bactericidal properties (Fuller & Higgins, *Chem. Abstr.*, 1941, **35**, 2627 & 2552).

India exports a large quantity of onions, the principal exporting areas being Madras and Bombay. A considerable quantity goes to Japan, the Straits Settlements, the Federated Malay States, Burma, Ceylon, Hongkong, Portuguese East Africa and Persia.

AVERAGE ANNUAL EXPORTS OF ONION

Quinquennium ending	Qty. 1,000 cwt.	Val. Rs. 1,000
'33-34	803	2,791
'38-39	966	3,386
'43-44	1,058	4,246
In '44-45	592	5,842
,, '45-46	638	7,092

A. porrum Linn. WINTER LEEK

D. E. P., I, 171; Fl. Br. Ind., VI, 337; Knott, Fig. 56.

ARAB.—*Kirath, kiras*; BENG.—*Paru.*

The leek is a native of Europe and West Asia. It is a tall hardy biennial with white, narrowly ovoid bulbs and broad leaves. It resembles the green onion, but is much larger. In India and Ceylon, it thrives well at higher altitudes, though not in moist localities. It is a garden crop and is grown during the cold season.

Leek is mild-flavoured and is used to spice curries.

A. porrum contains: moisture, 78·9; proteins, 1·8; fat, 0·1; carbohydrates, 17·2; Ca, 0·05; P, 0·07%; Fe, 2·3 mg.; vitamin A, 30 I. U.; vitamin B, 75 I. U. and vitamin C, 11mg./100g.; (*Hlth. Bull., loc. cit.*, 33). It is also comparatively rich in combined sulphur (0·06–0·072%. Wehmer, I, 153).

A. fistulosum Linn., the 'Welsh onion or Ceboule' is used as a substitute for leek.

A. sativum Linn. GARLIC

D. E. P., I, 172; C. P., 58; Fl Br. Ind., VI, 337; Bentley & Trimen, Pl. 280.

SANS.—*Arishtha, lashuna*; ARAB.—*Saum*; PERS.—*Sir*; HIND. & GUJ.—*Lasan*; BENG. & MAR.—*Lasun*; TEL. & MAL.—*Velluli, tellagadda*; TAM.—*Vellaipundu*; KAN.—*Bellulli.*

Garlic has long been cultivated in India as an important spice or condiment crop. It is a hardy perennial with narrow, flat leaves, and bears small, white flowers and bulbils. The bulb consists of several smaller bulbs called 'cloves', and is surrounded by a thin white, or pinkish sheath. Garlic has a stronger flavour than onion or its other allies. No distinct varieties are cultivated.

Garlic grows under much the same conditions as the onion, except that it favours a richer soil and a higher elevation (3,000–4,000′). A well-drained, moderately clayey loam is best suited for its cultivation. It requires a cool moist period during growth and a relatively dry period during the maturing of the crop. It takes longer (4–5 months) than onion to mature, and is consequently grown as a late season irrigated crop. In south India, it is rotated with *ragi* (*Eleusine coracana*), chillies, maize, potatoes and beans (Yegna Narayan Aiyer, 320).

The cloves or separated bulbs are planted during Sept.–Oct. in the plains, and Feb.–March in the hills. About 250–300 lb. of bulbs are required to plant an acre. The bulbs begin to form in about two months.

The land yields good results when treated with farmyard manure and a top-dressing of ammonium sulphate mixed with superphosphate (at 1 cwt. per acre).

The crop matures in about four months, when the leaves turn yellow and the bulbs show themselves slightly above ground. The bulbs are then pulled out, cured and stored.

The crop is harvested during Feb.–Apr. or May. An ordinary yield per acre is about 1,500 lb., a good yield being about 2,500 lb. In Bombay, high yields of 8,000–10,000 lb. per acre are obtained with a corresponding high seed rate of about 700 lb. of bulbs per acre. Usually the yield is 10 times the bulbs planted (Yegna Narayan Aiyer, *loc. cit.*).

The fungi, *Erysiphe taurica* Lev., *Alternaria palundi* and *Rhizopus* sp., are found on garlic and are kept down by spraying with Bordeaux mixture (Yegna Narayan Aiyer, *loc. cit.*). Thrips are controlled by spraying with tobacco decoction or dusting with tobacco powder.

Garlic is much used in Indian cookery as a condiment or spice. It contains: moisture, 62·8; protein, 6·3; fat, 0·1; carbohydrates, 29·0; Ca, 0·03; P, 0·31%; Fe, 1·3 mg.; vitamin C, 13 mg./100g. (*Hlth. Bull., loc. cit.*, 36). It is also reported to contain copper.

Preparations of garlic have been given in pulmonary phthisis, bronchiectasis, gangrene of the lung, and whooping cough. Laryngeal tuberculosis, lupus, and duodenal ulcers are treated by garlic juice. Inhalation of fresh garlic juice is useful in pulmonary tuberculosis (Martindale, I, 167). It has been found useful in atonic dyspepsia, flatulence and colic (Chopra, 274).

In external application, the juice is used as a rubefacient in skin diseases and as ear-drops in ear-ache. The juice diluted with water can be used as a lotion for washing wounds and foul ulcers (Chopra, 273).

The bulbs, on distillation, yield 0·06–0·1% of an essential oil ($d/14·5°$, 1·0525) containing allylpropyl disulphide, $C_6H_{12}S_2$ (6%), diallyl disulphide $C_6H_{10}S_2$ (6%), and two more sulphur containing compounds (Parry, 92). The oil is rarely used medicinally, although it has been recommended for internal use as a tonic and stimulant to the stomach, and as a vermifuge. Its chief use is to spice foods.

A. schoenoprasum Linn. CHIVES OR CIVES

D. E. P., I, 174; Fl. Br. Ind., VI, 338.

The chive is a native of Europe and adjoining parts of Asia, and in India, it is grown as a garden crop. It is a hardy perennial growing in dense clumps, with light green or purple tinted, grasslike leaves, and clusters of narrow, weakly developed bulbs at the base of the leaves. The onion flavoured leaves and bulbs are used for seasoning salads.

ALLOPHYLUS Linn. SAPINDACEAE

D. E. P., I, 175; Fl. Br. Ind., I, 673.

A large genus of shrubs or small trees, comprising about 120 species found in tropical and subtropical regions. *A. cobbe* Blume, a large variable shrub, is met with throughout south India, and in Khasia hills, Chittagong, Burma and the Andaman Islands. The wood (wt., 40 lb. per c.ft.) is moderately hard and is chiefly used as fuel. The fruits are said to be edible (Gamble, 193).

Almond, see Prunus amygdalus

„ , **Indian** – see **Terminalia catappa**

„ , **Java**— see **Canarium commune**

ALNUS Mill. BETULACEAE

A genus of deciduous trees or shrubs, comprising about 25 species, distributed in temperate Asia, Europe and America. The two Indian species are timber trees of minor importance.

A. glutinosa (Linn.) Gaertn., the alder, furnishes a durable and beautifully mottled wood, used extensively for barrels in Europe.

A. nepalensis D. Don INDIAN ALDER

D. E. P., I, 176; Fl. Br. Ind., V, 600; Pearson and Brown, II, 969.

HIND.—*Utis*; PUNJ.– *Kohi*; LEPCHA– *Kowal*; BURM.– *Maibau*; TRADE—Indian Alder.

A large deciduous tree attaining a height of 80–100′ with a straight cylindrical trunk up to 6–8′ in girth. It is found growing gregarious, in moist shady ravines throughout the Himalayas, from Kashmir eastwards to the Khasia Hills in Assam, and southwards to Kachin Hills in Burma.

The sapwood is white and the heartwood is reddish-white when fresh, turning to light brownish-grey on exposure. It is a smooth, spongy light wood (sp. gr., 0·32; air-dry wt., 37 lb. per c.ft.).

The timber is moderately durable, easy to saw, and seasons well. In order to prevent discoloration, it should be open-stacked, soon after conversion.

Indian alder is used only to a limited extent for tea-boxes, in house construction and in carpentry. It is used for hooked sticks in rope bridges.

The bark is reported to contain 7% of tannin (*Indian For. Leafl.*, No. 72, 1944). It is used in dyeing to deepen the colour of *Rubia cordifolia* (Fl. Assam, IV, 327).

A. nitida. Endl.

D. E. P. I, 177; Fl. Br. Ind., V, 600; Troup, III, Fig. 338.

U. P. *Utis, kunis*; PUNJ.—*Sharol*; KASHMIR—*Chamb*.

A large tree (80–100′ high; 6–12′ girth), distributed gregariously along the banks of rivers and moist ravines, from the Jumna westwards to Kashmir in the Himalayas, at altitudes between 3,000–9,000′.

It has a reddish-brown to light brownish-grey or roseate-grey wood, with a straight grain and an even texture. The wood is very light (sp. gr., 0·43; air-dry wt., 28 lb. per c.ft.) with a satiny lustre. It is a soft, moderately durable wood, which saws and works easily under tools. It seasons well if converted from green logs and then open-stacked. It is used for the same purposes as the wood of the preceding species. The bark contains 3% tannin (*Indian For. Leafl., loc. cit.*).

ALOCASIA Neck. ARACEAE

A genus of herbs with a root-stock bearing a short succulent stem with large variegated leaves. It includes about 65 species, distributed in tropical Asia, of which 12 are found in India.

A. cucullata Schott, *A. indica* and *A. macrorrhiza* are cultivated for their edible stems and root-stocks, especially in Bengal and Assam. A few species like *A. indica* var. *metallica* Schott and *A. lowii* Hook. are grown in gardens for their ornamental leaves. Some are medicinal.

Needle-like crystals of calcium oxalate are found in the tissues of alocasias. Some species are reported to contain hydrocyanic acid (Burkill, I, 105).

A. indica (Roxb.) Schott GIANT TARO

D. E. P., I, 178; Fl. Br. Ind., VI, 525; Kirt. & Basu, Pl. 1003.

SANS.—*Manaka*; HIND.—*Mankanda*; BENG.—*Mankachu*.

A tall aroid with an underground rhizome, bearing a succulent swollen stem, 4–8″ in diameter. It is cultivated in Assam and Bengal as a food crop. It is also an ornamental plant.

The stems and root-stocks are edible, if boiled and washed thoroughly. When the root-stock is pulped and washed, it yields a pure white starch (Dymock, Warden & Hooper, III, 545). The flour obtained is a light nutritious food, suitable for invalids. It is somewhat mucilaginous and is considered to be more easily digestible than rice.

The leaf juice is astringent. The rhizome is said to act as a mild laxative and diuretic, and is considered useful in anasarca.

A. macrorrhiza Schott GIANT TARO

Fl. Br. Ind., VI, 526.

ASSAM—*Boro mankachu*.

It is one of the largest aroids, with a thick stem usually 3–6′ high and 1′ in diameter. It occurs both wild and under cultivation in many tropical parts of the country.

The stems possess an acrid taste and cause irritation in the mouth. This is due to crystals of calcium oxalate. They contain 20·45% of starch (Valenzuela and Wester, *Philip. J. Sci.*, 1930, **41**, 85), and are eaten in times of scarcity. Before use they should be sliced, washed and boiled, and the water thrown away.

The juice of the stem is reported to relieve scorpion sting as well as nettle sting (*Laportea gigas* Wedd.). In Java, the roots and leaves are used as a rubifacient for pains in joints (Burkill, *loc. cit.*).

Aloe , Blue Elephant—see **Agave vera-cruz**

„ **, Bombay**—see **Agave cantala**

„ **, Dwarf**—see **Agave angustifolia**

ALOE Linn. LILIACEAE

A genus of about 180 species of xerophytic plants indigenous to East and South Africa. Several species have been introduced into India, the East and West Indies and other tropical countries and also Europe. Some of them are arborescent and others are herbs. The aloe flourishes in a variety of climates and on the poorest soil. Its fleshy and strongly cuticularised leaves are usually prickly at the margin and are arranged in dense rosettes.

When a leaf is transversely cut and held with its cut end downwards, a yellowish juice flows out from the pericycle, associated with vascular bundles. This juice is collected and concentrated. The

extract on cooling solidifies and constitutes the drug aloes. The mucilage, present in the central part of the leaf, is almost inactive.

The nature of aloes depends upon the species from which it is prepared and the manner in which the juice is concentrated. If the juice is dried in the sun, or concentrated over a low fire, it gives an amorphous, opaque, waxy extract called 'hepatic' or 'livery' aloes. But if the juice is concentrated rapidly over a strong fire, the material obtained on cooling is amorphous, and semi-transparent, and is called 'glassy' or 'vitreous' aloes. Four varieties of aloes are official in the B. P.:

(i) Curaçao or Barbados aloes (chocolate brown), from *A. vera* Tourn. ex Linn. var. *officinalis* (Forst.) Baker, (ii) Socotrine aloes (yellowish or blackish brown) from *A. perryi* Baker, (iii) Zanzibar aloes (livery brown), also derived from *A. perryi*, and (iv) Cape aloes (dark brown or greenish brown), from *A. ferox* Mill. and its hybrids. Of these Curaçao, Socotrine and Zanzibar aloes are 'hepatic', and Cape aloes is 'glassy'.

Besides the official aloes, Natal aloes, derived probably from *A. candelabrum* Berger, resembling Cape aloes, 'Moka' or 'Mocha' aloes derived from *A. succotrina* Lam. (Arabia), and Jaffarabad aloes, produced from *A. vera* at Jaffarabad are also in use.

Aloes contains a mixture of glucosides collectively called 'aloin' which is the active constituent of the drug. The proportion of 'aloin' varies in different aloes. Curaçao aloes contains about 30%, Socotra and Zanzibar aloes, a little less, and Cape aloes, only about 10%. The principal constituent of 'aloin' is barbaloin which is a pale-yellow crystalline glucoside soluble in water. Among the others mention may be made of isobarbaloin (Curaçao aloes), β-barbaloin, aloe-emodin (a hydrolytic product of barbaloin), resins and some water soluble substances. The odour is due to traces of an essential oil. The B. P. limits the ash content to 5% and the loss on drying at 100° (moisture, etc.) to not more than 10%.

Aloes has a bitter, disagreeable taste, and is largely used as a cathartic and is valuable in the treatment of constipation, but is not suitable for being used in pregnancy. It produces pronounced pelvic congestion and is used for uterine disorders, generally with iron and carminatives. Aloes forms one of the constituents of several proprietary laxative preparations.

In the earlier part of this century, trade in African and Arabian aloes used to pass through Bombay, and some locally produced aloes (Madras and Mysore) was being exported to the Straits Settlements, but now there is no export trade. Aloes was being imported from South Africa and Germany, but the quantity imported has gradually declined. In the quinquennium ending '29–34 the average annual imports were 1,016 cwt., valued at Rs. 25,903, and in the following quinquennium, 454 cwt., valued at Rs. 11,245; in '39–44 annual imports were only 57 cwt. valued at Rs. 2,717.

A. vera Tourn. ex Linn. = *A. barbadensis* Mill.
CURAÇAO ALOE, BABADOS ALOE, INDIAN ALOE, JAFFARABAD ALOE

D. E. P., I, 186; C. P., 59; Fl. Br. Ind., VI, 264; Pl. XI, 3.

SANS. & BENG.—*Ghrita-kumari*; ARAB.—*Sabbara*; PERS.—*Darakhte-sibr*; HIND.—*Ghee-kunvar*; MAR.—*Korphad*; GUJ.—*Kumarpathu*; TAM.—*Chirukattali*; TEL.—*Chinna-kata banda*; KAN.—*Loli-sara*; MAL.—*Kumari*.

A coarse looking plant with a short stem, 1–2′ high. The fleshy leaves (about 15″ long, 4″ broad, ¾″ thick), are densely crowded.

A. vera is a native of north Africa, Canary Islands and Spain, and has spread to East and West Indies, India, China and other countries. Many of the forms of this species are naturalized in India and are found in a semi-wild state in all parts from the dry westward valleys of the Himalayas up to Cape Comorin. The plants are generally propagated by suckers.

There are 2–3 easily recognizable varieties found in India, but their exact delimitations are not clear. In *A. vera* var. *chinensis* Baker, common all over the Deccan and the C. P., the leaves have a distinct purple colour towards the base and the spines are not sharp. The leaves of *A. vera* var. *littoralis* Koenig ex Baker, found on the beach shingles in Madras right up to Rameswaram are smaller in size and have a dentate margin. Another variety which thrives on the Kathiawar coast is the source of Jaffarabad aloes. This has also been called *A. abyssinica* by some authors.

A. variegata Linn. a near ally of *A. vera* is found in parts of the Bombay province. It has large fleshy green leaves with sharp spines and white specks at the bases of the leaves.

In Indian medicine also, aloes (mosabbar) is used as a stomachic, purgative and emmenagogue. It is regarded as valuable in the treatment of piles and rectal fissures. The mucilage is cooling and is used to poultice inflammations.

Jaffarabad aloes is also used in lacquer work (Chopra and Ghosh, *Arch. Pharm., Berl.*, 1938, **276**, 348).

Chopra and Ghosh (*loc. cit.*) examined the juice of *A. vera* var. *officinalis* (?) and found that it contained no aloin, but only some resin and gum, with small quantities of anthra-quinone derivatives such as emodin and chrysophanic acid. Jaffarabad aloes have been reported to contain 13·6% aloin without any isobarbaloin (Wehmer, I, 150).

Aloe wood, see **Aquilaria agallocha**

ALOPECURUS Linn. GRAMINEAE

D. E. P., I, 190.

A genus of tall, slender grasses, comprising about 25 species, indigenous to temperate Europe and Asia. Six species are common in India. *A. geniculatus* Linn. (March Fox-tail), *A. myosuroides* Huds. (Slender Fox-tail), and *A. pratensis* Linn. (Meadow Fox-tail), mostly found in temperate and sub-tropical Himalayas and Khasia hills, are good forage grasses.

ALPHONSEA Hook. f. & Thoms. ANNONACEAE

Fl. Br. Ind., I., 89.

A genus of small trees or shrubs occurring in tropical Asia. 12 species are known and about 5 are found in India, chiefly in the north-west and in Ceylon. *A. ventricosa* Hook. f. & Thoms. is a tall tree of Assam, Chittagong and the Andamans. Its timber is used in boat building and for making bows (Gamble, 23). Its leaves are said to contain 0·5% of an alkaloid (Wehmer, 1, 344).

ALPINIA Roxb. ZINGIBERACEAE

A genus comprising about 40 spp. of aromatic herbs, distributed in the Old World tropics, and for sometime called *Languas* Koenig. 17 spp. are represented in India, and some are medicinal. *A. galanga* Willd. provides the 'greater galangal' of commerce. The imported drug, 'lesser galangal' is obtained from the rhizome of *A. officinarum* Hance, of China. *A. allughas* Rosc., *A. calcarata* Rosc., *A. conchigera* Griff., *A. mutica* Roxb., *A rafflesiana* Wall., and *A. scabra* Baker are sometimes used as substitutes for galangal. A few species are ornamental.

A. galanga Willd. THE GREATER GALANGAL

D. E. P., I, 192 ; Fl. Br. Ind., VI, 253.

SANS., HIND., & BENG.—*Kulanjan* ; MAR.—*Kosht-kulinjan* ; TAM.—*Pera-rattai* ; TEL.—*Pedda-dumparashtram* ; KAN.—*Dumbarasme*.

A. galanga Willd. is distributed mainly in the eastern Himalayas and south-west India. The plant is 6–7′ high, and bears perennial rhizomes which are deep orange-brown in colour, aromatic, pungent and bitter. The fruits are about ½″ long, constricted in the middle, and contain 3–6 seeds. The latter are slightly pungent, with an aroma similar to that of the rhizome. Cut pieces of the rhizome of this species are known as 'greater galangal'. The rhizome of 'lesser galangal', *A. officinarum*, is smaller and reddish brown in colour, and has a stronger odour and taste.

The green rhizomes contain 0·04% essential oil, (d/19°, 0·978–0·985 ; $[\alpha]_D$ + 4–6° ; n_D, 1·5164 ; ester val., 145·6). It consists of methyl-cinnamate (48 %), cineol, 20–30%, some camphor, and probably *d*-pinene. Leaves also yield a volatile oil (Wehmer, I, 180).

In indigenous medicine, the rhizomes are used in rheumatism and catarrhal affections, specially in bronchial catarrh. The drug is a depressant of the cardio-vascular system. Respiration in experimental animals is stimulated by small doses but depressed by larger ones. It has important action on the bronchioles. It is useful in respiratory troubles, specially of children (Chopra, 277.) The rhizomes are also carminative and stomachic (Kanny Lall Dey, 180). In Malaya, they are used as spice, and the fruits as substitutes for cardamoms.

Small quantities of greater galangal used to be exported from India. But there has been no export since 1937-38.

A. malaccensis Rosc.

Fl. Br. Ind., VI, 255.

A tall plant, 10′ high, found in the Himalayas, the Eastern and Western Ghats, and the hills of Bengal and Assam.

The rhizome yields 0·25% volatile oil ($d/27°$, 1·039–1·047; $[\alpha]_D$, +1·5°; n_D, 1·5477; sap. val., 256–278). It contains 74–80% methylcinnamate. Leaves give 0·16% of oil, 'essence of Amali' (Burkill, II, 1310), consisting largely of methylcinnamate, 75% (Parry, 101).

The rhizomes are reported to be used in Java for sores. The fruits, infused with a little salt, are emetic (Burkill, *loc. cit.*).

A. speciosa K. Schum. Syn. *A. nutans* Rosc. THE LIGHT GALANGAL

D. E. P., I, 195; Fl. Br. Ind., VI, 256.

BENG. *Punag-champa.*

This species is a native of north-eastern India and Burma, and grows to a height of 8–10′. It is also cultivated in gardens.

The leaves contain 0·05% ethereal oil (d, 19°, 0·930; $[\alpha]_D$, +38·4°; n_D, 1·4750; sap. val., 10·0; sap. val. after acetylation, 36·1). It contains about 30% *d*-camphor, 17% *d*-camphene, cineol, cinnamic ester, etc. The root-stock also yields an ethereal oil (Wehmer, I, 180).

The fibrous stems contain 49·9% of cellulose and can be used for making paper (*Bull. imp. Inst., Lond.*, 1927, **25**, 122).

The rhizome of this plant is used as a substitute for galangal, and sometimes also for ginger.

ALSEODAPHNE Nees LAURACEAE

A genus of evergreen trees, distributed in the Indo-Malayan forests. It includes 10 species, five of which are found in India.

A. semecarpifolia Nees

Fl. Br. Ind., V, 144; Beddome, Pl. 297.

MAR.—*Phudugus*; TAM.—*Yavaranai*; KAN.—*Massi*; SINGH.—*Wewarani.*

This large tree is found in the Western Ghats from Kanara to Cape Camorin up to 5,000′, and further southwards in the drier parts of Ceylon.

The timber is yellowish when fresh, but becomes light brown on exposure. It is fairly heavy (63 lb. per c. ft.), moderately hard and seasons readily (Gamble, 568). It is useful for plywood tea chests (Limaye and Mohammed, *Indian For. Rec., New Series, Util.*, 1942, **2**, 186).

The timber from *A. petiolaris* Hook. f., occurring in Assam, is used locally for boats and furniture.

ALSTONIA R. Br. APOCYNACEAE

This is a genus of small or medium-sized trees, distributed from Africa to the Pacific, but mainly concentrated in the Indo-Malayan region. It comprises about 30 species, 6 of which occur in India.

The dried bark of many species, particularly of *A. constricta* F. Muell. (Australian species) and of *A. scholaris* is used as a bitter tonic and febrifuge. The tincture and decoction of *A. scholaris* are included in the B. P. C. The bark once enjoyed considerable reputation throughout the tropics as a remedy for malaria.

A. scholaris R. Br. DITA BARK

D. E. P., I, 197; C. P., 60; Fl. Br. Ind., III, 642; Pl. XIII, 1.

SANS.—*Saptaparna*; HIND.—*Chatian*; BENG.—*Chattim*; MAR. *Satvin*; TAM. & MAL. *Pala*; KAN.—*Maddale*. Trade—Chatiyan or Shaitan Wood.

This is a large evergreen tree with a straight, often fluted and buttressed stem, 40′ high and up to 8′ in girth. The bark is yellow inside and exudes a milky juice, when injured. The tree is found throughout the moister regions of India, especially in the West Coast forests, but is nowhere very abundant. It also occurs in Burma, Ceylon, Malaya, East Indies and in the Philippines.

In indigenous medicine, the bark is regarded as a bitter tonic and febrifuge, and is popularly used in the treatment of malaria. It is also stated to be useful in diarrhoea and dysentery (Chopra, 278).

The total alkaloidal content of Indian bark is stated to be 0·16–0·27%, and 0·08–0·10% of the hydrochloride of the chief alkaloid echitamine, $C_{22}H_{28}O_4N_2 \cdot H_2O$, m.p., 206° (Goodson, *J. chem. Soc.*, **1932**, 2626). But higher values have been reported (0·5% of echitamine) in bark from Shimoga area in Mysore (Siddappa, *J. Mysore Univ.*, 1945, **5**, 63). From the mother liquor of echitamine, Goodson (*loc. cit.*) has isolated small quantities

of another crystalline alkaloid, echitamidine, $C_{20}H_{26}O_3N_2$, m.p., 135·6° (*vide* also Henry, 600).

Among the non-alkaloidal constituents, Goodson (*loc. cit.*) has isolated two isomeric lactones, $C_9H_{14}O_3$, of m.p., 103° and 107°. The bark is also rich in sterols (Goodson and Henry, *J. chem. Soc.*, 1925, **127**, 1640, see also Siddappa, *loc. cit.*).

Bacon (*Philip. J. Sci.*, 1906, **1**, 1007) found that amoebae, suspended in a solution of echitamine (1%) appeared to thrive and showed no decrease in mobility even after two hours. It was concluded that the alkaloid, not being a protoplasmic poison like quinine or emetine is of no value in malaria or amoebic dysentery. Goodson, Henry and Macfie (*Biochem. J.*, 1930, **24**, 874) have shown that in a dosage of 5 mg., the alkaloid is only feebly active in bird malaria. According to Mukerjee, Ghosh and Siddons (*Indian med. Gaz.*, 1942, **77**, 723), the total alkaloids (0·3%) isolated from *A. scholaris*, and also a tincture (1 in 10) made from the powdered bark have, contrary to popular belief and earlier records of clinical trials with the drug, little or no demonstrable action in malaria induced in monkeys, or naturally occurring in human patients. Gupta, Siddons and Chakravarti (*ib.*, 1944, **79**, 408) have further shown that it exercises no synergitic action on quinine. The drug, however, is of value as a febrifuge (Central Indigenous Drugs Comm., 1909, 19, 20; Koman, 1919, 12).

Echitamine is found to be toxic to mice in doses of 0·3–0·5 mg. per 20 g. (Henry, 603). In cats, dogs and monkeys, it induces an initial fall in blood pressure, which is unaffected by atropinisation, and is followed by a rise (Mukherjee *et al.*, *loc. cit.*; and Venketachalam and Sastry, *Indian J. vet. Sci.*, 1943, **13**, 328). The presence of a blood sugar reducing principle in the bark of *A. scholaris* has also been reported (*Chem. Abstr.*, 1932, **26**, 253).

The latex is found to contain 2·8–7·9% caoutchouc. The coagulum contains: caoutchouc, 12·9–26·5 and resins, 69·0–78·7% (*Indian For. Leafl.*, No. 70, 1944, 4). It tastes bitter and is said to be applied to sores and ulcers.

The wood of *A. scholaris* is white when first exposed, but gradually turns yellowish to pale-brown. It is light, lustrous, smooth and tastes bitter when fresh (sp. gr., 0·47; air dry-wt., 26–30 lb. per c.ft.).

It saws and works well, finishing to a dull, moderately smooth surface. It is not a durable timber, but green conversion and seasoning in running water is likely to increase its durability. It is liable to sapstain, decay and insect attacks, if not properly seasoned (Pearson and Brown, II, 727).

It is mostly used for packing cases, tea boxes, writing boards and minor furniture. It could also be employed for plywood, and second class matches and is recommended for the manufacture of second grade pencils (*Indian For. Leafl.*, No. 66, 1945, 2).

The ultimate fibre from the bark has a length of only 1·2 mm. It is not suitable for making paper (Burkill, I, 115).

ALTERNANTHERA Forsk. AMARANTHACEAE

A genus of herbs, including about 70 species distributed in tropical and temperate countries. Two species are found in India.

A. sessilis R. Br.

D. E. P., I, 199; Fl. Br. Ind., IV, 731; Pl. XIII, 4.

TEL.—*Ponnaganta kura*; TAM., & MAL. *Ponnaganni-keeray*; KAN.—*Honagone soppu.*

A prostrate herb, occurring as a weed throughout India and Ceylon. It is often cultivated as a pot herb.

The young shoots are nutritious and contain protein, 5% and iron, 16·7 mg./100 g. (*Hlth. Bull.*, No. 23, 1941, 30).

ALTHAEA Linn. MALVACEAE

D. E. P., I, 199; Fl. Br. Ind., I, 319.

A small genus of herbs, comprising about 15 species, distributed in the temperate regions, of which two are native to India. *A. officinalis* Linn. (Marsh Mallow), is a perennial herb with ornamental flowers, occurring in the Punjab and Kashmir. The roots contain mucilage, 35%, and starch, 37% (Wehmer, II, 758). It is an emollient and is used in making absorbent pills and pastilles. The leaves were formerly used in the preparation of a soothing ointment (Martindale, I, 558). It is official in the U. S. P.

1. ALSTONIA SCHOLARIS

2. AMARANTHUS BLITUM

3. AMARANTHUS SPINOSUS

A. rosea Cav. (Holly-hock), is an ornamental plant. Its flowers yield a red dye (anthocyanins) which may be used as an indicator in acidimetry and alkalimetry (Sobyanin and Soakov, *Chem. Abstr.*, 1930, **24**, 2962). Its seeds contain 11·9% of a drying oil (Wehmer, II, 758).

ALTINGIA Noronha HAMAMELIDACEAE

A genus of trees, comprising 3 species, distributed in the Indo-Malayan region and China. *A. excelsa* grows to an enormous size on the hills in Java, where it forms the chief building material. In India, it is a timber tree of the second class.

A. excelsa Noronha

D. E. P., I, 201 ; C. P., 61 ; Fl. Br. Ind., II, 429 ; Kirt. & Basu, Pl. 407A.

HIND.—*Silaras* ; ASSAM—*Jutuli* ; BURMA—*Nantayok*.

A large deciduous tree, with a straight cylindrical shaft, 60–80′ high and girth up to 10′. It is found in Assam and Burma.

The wood is reddish-brown to brown, with a smooth feel. It is moderately heavy (sp. gr., 0·77 ; air-dry wt., 48 lb. per c.ft.), with a fine, even texture and irregularly interlocked grain.

It is a very durable timber under cover. It works with difficulty and is liable to crack if not properly seasoned. It is seasoned by converting green logs and stacking them in close piles, protected from hot dry winds.

It is a good timber, used in Assam and Burma, for planking and internal construction. The timber after treatment with creosote, can be used for railway sleepers and in the construction of wagons.

Small quantities of aromatic resin, similar but inferior to storax, exude from wounds in the bark. According to Kraemer (333) two aromatic balsams, one white and crystalline, and the other brown, can be obtained from the tree. Both contain cinnamic esters.

ALUM AND ALUMINOUS SULPHATES

Alum used to be manufactured in India from 'alum shales', occurring in several parts of the country. These result from the weathering of pyritous shales. On oxidation, the finely disseminated grains of pyrites give rise to iron sulphate and sulphuric acid. The latter reacting with alumina in the shales forms aluminium sulphate. The preparation of alum from such shales as practised in Mianwali dist. in the Punjab, and with minor variations in other parts of India, has been described by Daru (*Rec. geol. Surv. India*, 1910, **40**, 265).

Alum shale suitable for the manufacture of alum is called *rol* in the Punjab, and contains on an average 9·5% of sulphur. The shale is made into heaps with brushwood and fired in the open to oxidise sulphur to form sulphuric acid and sulphates. It is then leached with water, and the solution concentrated in open boiling pans. On the addition of a suitable quantity of *shora* (crude nitre containing some sulphates of sodium and potassium) and wood ashes, and allowing to stand, crystals of crude alum separate out. These are removed and recrystallised. This alum was being used in the dyeing and tanning industries of Delhi, Hissar, etc.

In India, alum is now manufactured on a large scale from bauxite and sulphuric acid, for use in water purification, and in industries.

DISTRIBUTION

The occurrence of alum shales which were used for the manufacture of alum are given below :

Bihar : Beds of alum shales (up to 10′ in thickness) occur at the base of sandstones near Rohtasgarh (24°38′ : 83°55′), and in the valleys of the Durguti and Sulgia-Koh rivers in Shahabad dist., where there were extensive works engaged in the manufacture of alum.

Bombay : Considerable quantities of alum used to be manufactured from pyritous shales at Mhurr (23°32′ : 68°57′) in Cutch State.

North-West Frontier : Alum shales occur at Jatta (33°19′ : 71°17′) and also in the gorge near Bozha Banda in Kohat dist. There were once extensive sulphur or alum works on the right bank of the Indus river near Dandi Hill station on the road from Chorlakki to Dandi (33°36′ : 71°59′), about 2 miles from the former place.

Punjab : In Jhelum dist., highly pyritous shales occur associated with the Tertiary coal-seams at Dandot colliery (32°39′ : 72°58′). The manufacture of alum from black shales of the same horizon as at Dandot was formerly carried on at Virgal (32°27′ : 72°4′) and Amb (32°3′ : 71°56′), in Shahpur dist.

In Mianwali dist., the dark sulphur-bearing shales of the Lower Eocene age at Kalabagh (32°58′: 71°33′) and at Chichali (33°0′ : 71°24′) have been used for the manufacture of alum. The thickness of alum shales varies from 7–10′ at Kalabagh, and from 25–40′ at the Chichali pass near Kotki. In 1922, there was an output of 332 tons of alum (valued at about one lakh of rupees) from Mianwali dist., but production ceased after 1929.

Rajputana : Alum was obtained in considerable quantities as a by-product in the manufacture of copper and iron sulphates from the decomposed shales containing copper pyrites and iron pyrites at Khetri (28°0′ : 75°47′) and Singhana (28°6′ : 75°50′) in Jaipur State and at Daribo (27°10′ : 76°23′) in Alwar State.

Sind : Alum has been manufactured from pyritous shales on the Maki Nai (27°2′ : 67°21′) and at many other places on the hills of western Sind, and also at Ranikot (25°52′ : 67°55′) and Bill (25°38′ : 67°31′) in Karachi dist. Another locality where alum was manufactured is Shah Hassan near Trini (26°23′ : 67°4′).

Occurrences in India of other aluminous sulphates, such as aluminite, alunite, alunogen and kalinite (potash alum) have been reported, but nowhere are they found in workable quantities. In Koh-i-Sultan (Baluchistan) natural alum is often found as a gangue mineral associated with sulphur.

ALYSICARPUS Neck. LEGUMINOSAE

It is a small genus of herbs, including about 10 species, distributed throughout the tropical regions. 9 species are found in India. A few like *A. pubescens* Law, *A. rugosus* DC., and *A. longifolius* Wight & Arn. are good fodder plants and are used in Bombay both as dry and green fodder (Burns, Bhide, Kulkarni, and Hanmante, *Dep. Agric.. Bombay, Bull.* No. 78, 1916, 21).

The roots of *A. longifolius* are sweet (Dymock, Warden & Hooper, I, 447).

A. vaginalis DC. is a good forage legume in the Philippines. In Malaya, it is grown as a cover-crop in rubber plantations and a decoction of the roots is said to be used in Java for coughs (Burkill, I, 121).

AMARANTHUS Linn. AMARANTHACEAE

The genus *Amaranthus* includes about 60 species of annual herbs, distributed in the tropics, of which some 25 occur in India. A few, such as *A. gangeticus*, are cultivated for use as pot-herbs. *A. caudatus* and *A. paniculatus*, are grown in the hill tracts as grain crops. Almost every species is eaten by cattle.

Some are grown in gardens for their brightly coloured spikes and variegated foliage, e.g. *A. salicifolius* Hort. (Weeping Willow-leaved Amaranth), *A. caudatus* Linn. var. *alopecurus* (Love lies bleeding) and *A. hypochondriacus* Linn. (Prince's feather).

A. blitum Linn.

D. E. P., I, 210 ; Fl. Br. Ind., IV, 721 ; Pl. XIII, 2.

SANS.—*Alpa marisha* ; HIND. & BENG.—*Sada natya, van natya* ; GUJ.—*Ukdi bhaja* ; MAR.—*Ranta durja.*

A procumbent annual, with small long petioled leaves. It is a common weed throughout India, and extends to other tropical and sub-tropical countries. It is used as a pot-herb, and is said to be rich in potassium nitrate (Wehmer, I, 298).

Var. **oleracea** Duthie

Duthie, III, 13.

SANS.—*Bashpaka, marisha* ; HIND.—*Chaulai, marsa* ; BENG.—*Sadanatya* ; MAR.—*Bhaji, dant* ; GUJ.—*Dambho* ; TEL.—*Totakura* ; TAM.—*Tandukirai.*

An erect succulent herb, with large oblong leaves. It is cultivated for use as a pot-herb throughout India, particularly in the submontane districts, and in Ceylon. Seeds are sown broadcast from April to August and the leaves and tender shoots are ready for harvesting in 30–40 days. The seeds are also roasted and eaten.

The plant contains 2·9% of protein and is fairly rich in iron, 18·18 mg./100 g. (Corpn. Calcutta, Food Values of Common Indian Foodstuffs, 1943, 4).

A. caudatus Linn.

D. E. P., I, 211 ; C. P., 63 ; Fl. Br. Ind., IV, 719 ; Duthie & Fuller, Pl. 68A.

HIND.—*Ram dana* ; BENG.—*Anantmul* ; TEL.—*Keikera* ; TAM.—*Siru kiray.*

A tall annual, with long petioled elliptic leaves, and bright yellow or deep red, pendulous spikes. The seeds are white or yellow, with a thick rounded border.

It is grown in the plains of India, as a pot-herb or as a garden plant. In the hills of northern India, it is cultivated as a field crop. Its seeds constitute the food grain 'Ram dana'.

A. gangeticus Linn.

D. E. P., I, 212; C. P., 62; Fl. Br. Ind., IV, 719; Kirt. & Basu, Pl. 790.

SANS.—*Ariki sira*; HIND.—*Lal sag, chaulai sag*; BENG.—*Dengua*; TEL.—*Tota kura*; KAN.—*Dantu*.

Greenish or dark red tender herbs with purple, tinted or dark-green leaves. There are many varieties, differing chiefly in the shape and colour of the leaves, the colour ranging from the slightest tinge of red to liver-coloured and bright red. The principal cultivated varieties are, *lanceolatus, lividus, polygamus, tristis*—all used as pot-herbs.

It is cultivated throughout India and Ceylon. Seeds are sown broadcast in May and June and the crop is harvested in 40–60 days.

The tender shoots contain: moisture, 85·8; protein, 4·9; fat, 0·5; carbohydrates, 5·7; mineral matter, 3·1; Ca, 0·5; P, 0·1%; Fe, 21·4 mg.; vitamin A, 2,500–11,000 I. U.; vitamin B_1, 10 I. U. and vitamin C, 173 mg./100 g. (*Hlth. Bull.*, No. 23, 1941, 29).

The seeds contain saponin which is only slightly toxic (Burkill, I, 125).

A. paniculatus Linn.

D. E. P., I, 210; C. P., 63; Fl. Br. Ind., IV, 719; Kirt. & Basu, Pl. 789.

HIND.—*Chua, chaulai*; BENG.—*Natya*; GUJ.—*Chuko*; TAM.—*Pungi kirai*; KAN.—*Kire soppu*.

A tall annual, with long petioled leaves and drooping spikes. The small seeds are yellowish white, red or black.

The species is Asiatic and has been under cultivation throughout India, chiefly in mountainous tracts. It is also found under cultivation on the hills of Ceylon, Burma and western China. Seeds are sown during May–June and the crop is harvested during Oct.–Nov. In the plains, it is raised as a *rabi* crop and is harvested during February-March.

The tender shoots and leaves are used as vegetable. The seeds furnish 'anardana', a food grain used by the poor. They contain 55–60% starch (Harrison and Bancroft, ex Burkill, I, 127).

A. spinosus Linn. PRICKLY AMARANTH

D. E. P., I, 215; C. P., 63; Fl. Br. Ind., IV, 718; Pl. XIII, 3.

SANS.—*Tanduliya*; HIND.—*Kataili chaulai*; BENG.—*Kanta notya*; MAR.—*Kante math*; GUJ.—*Kantanu-dant*; TEL.—*Mullatota-kura*; TAM.—*Mulluk-kirai*; KAN.—*Mullu harive soppu*; MAL.—*Kattu-mullen-keera*.

An erect spinous herb varying in colour from green to red or purple. It is found as a field weed throughout India, and is used by the poor as a pot-herb. Boiled with pulses, it is also fed to cattle to increase the yield of milk.

The plant has considerable food value and contains: moisture, 85·0; protein, 3·0; fat, 0·3; carbohydrates, 8·1; mineral matter, 3·6; Ca, 0·8; P, 0·05%; Fe, 22·9 mg./100g. (*Hlth. Bull., loc. cit.*, 29).

AMBER

D. E. P., I, 216; C. P., 64.

ARAB.—*Incatarun*; PERS. & HIND.—*Kahroba*; BURM.—*Ambeng*.

Amber is a fossil resin derived from *Pinus succinifera* (Göppert) Cornw., an extinct conifer of the Tertiary period. It is usually found in beds of coal of Lower Tertiary age. The richest deposits of amber (Baltic amber) are in east Prussia and it is reported that in 1938, 16·4 metric tons were exported from this area. Amber is also found in Sicily, Madagascar and Burma. The demand for natural amber, however, has been on the decrease since the development of synthetic plastics which can be put to similar uses.

In India, small pieces of amber have been found associated with coal-seams in Assam, and with alum shales in Cutch. The lignites of Bikaner (Palana) and Travancore also contain fossil resin.

Burma has long been the source of amber in the East. It occurs in the lower tertiaries embedded in dark blue shales and sand-stones. It is generally found in elliptical or oval pieces, at a depth of 32–48′, but large lumps are rare. Almost all the amber mines are situated in Hukawng valley near Maingkwan, about 3 miles south-west of Shingban village (26°17′; 96°35′). In this area, Khanjamaw was the biggest centre of mining in 1930. Amber

workings are also found in Ladummaw (26°11′ : 96°28′), Lajamaw (26°15′ : 96°28′) and along the Kapdup *hka* (stream). Occurrences further south in the Tertiary strata at Mantha (22°54′ : 96°1′), and in the Yenangyat oil-field have been reported. Fossil resin is also found in the lignites of Thayetmyo dist. (Chhibber, 85).

In Burma, amber is mined in the most primitive way by digging shallow pits about 3½′ in diameter and up to 45′ in depth. The debris is hauled to the surface and searched for amber. A large proportion of the pieces found are opaque and discoloured, and contain cracks filled with calcite. According to Coggin Brown (303), round about 1906, production of amber ranged between 100–200 cwt. per annum. Since then, there has been a gradual decline, and in 1937, it was only 39 cwt., valued at Rs. 8,880.

Burmese amber (Pl. XX, 1) is also called burmite. It is somewhat heavier and harder (sp. gr., 1·034–1·095 ; H., 2·5–3·0) than Baltic amber and also possesses greater toughness. Consequently it is more suitable for turning and carving. Burmite varies in colour from pale-yellow to reddish-brown and is usually semi-transparent. It is remarkable for its strong fluorescence. A blue tinge appears when it is viewed at a certain angle, and this may be so marked that the entire specimen may look dull green. When rubbed, it takes a high polish, becomes negatively charged, and emits a characteristic odour. Burmite is mainly composed of carbon, hydrogen, and oxygen together with a trace of sulphur. It contains a much smaller proportion of combined succinic acid ($< 2\%$) than Baltic amber (4–8%).

Amber has been prized since the time of the Greeks and the Romans for making beads and ornaments, and Chinese amber carvings are of great antiquity. Amber is now employed also for making the mouth-pieces of cigars and cigarette holders.

The bigger blocks of amber reach China through Kamaing, Mogaung or Mandalay and a small quantity finds its way into the European market (Chhibber, *loc. cit.*). At Maingkwan the major portion of burmite is cut into ear-rings used by the hill-tribes of Assam and Burma, and at Mandalay and Mogaung, necklaces, ear-rings, beads, buttons, etc., are turned out.

Amber refuse obtained during the cutting and carving of amber is used in the preparation of varnishes. Some amber is also distilled for the volatile oil called amber-oil used in varnish making, and in pharmacy. But burmite has not been used for obtaining the oil.

AMBERBOA Less. Syn. *Volutarella* Cass.

COMPOSITAE

A genus of 5 species of annual herbs extending from the Mediterranean to India. *A. divaricata* Kuntze (syn. *Volutarella divaricata* Benth. et Hook. f.), found in India, is reported to be used as a tonic and laxative, and also for fevers and coughs (Kirt. & Basu, II, 1477; *vide* also Dymock, Warden & Hooper, II, 307).

Ambergris, see **Whales**

Amboyna wood, see **Pterocarpus indicus**

AMMANNIA Linn. LYTHRACEAE

A genus of small annual herbs, comprising about 20 cosmopolitan species found growing in marshy places in the tropics and in the warm temperate regions. About 18 species are met with in India.

A. baccifera Linn. BLISTERING AMMANIA

D. E. P., I, 218 ; Fl. Br. Ind., II, 569 ; Kirt. & Basu, Pl. 430.

HIND. & BENG.—*Dadmari* ; MAR.—*Bharjambhul* ; TAM.—*Kallurivi* ; TEL.—*Agnivendrapaku* ; MAL.—*Kalluravanchi*.

An erect herb, 6″–2′ high, found as a weed in rice fields and marshy localities throughout India.

The fresh leaves have been used in skin diseases as a rubifacient (Kanny Lall Dey, 23). They are said to be acrid.

AMOMUM Linn. ZINGIBERACEAE

A large genus of rhizomatic herbs, 3–12′ high, comprising 100 palaeotropical species, of which 30 are met with in India and Burma.

The spicy aromatic seeds of some species of *Amomum*, also called cardamoms, are cheaper substitutes for true cardamom (*Elettaria cardamomum*), which they resemble. *A. aromaticum* and *A. subulatum* are cultivated in India.

The seeds of *A. xanthioides* Wall., Malabar or Tavoy cardamom (Burma, Siam, and the Malay Peninsula), are imported. They are pale brown, somewhat smaller in size than true cardamom seeds, and possess a strong but agreeable odour (for a study of essential oil from them, see Karione and Yoshida, *Chem. Abstr.*, 1930, **24**, 4806).

A. aromaticum Roxb. BENGAL CARDAMOM

D. E. P., I, 221 ; Fl. Br. Ind., VI, 241 ; Kirt. & Basu, Pl. 943.

HIND. & BENG.—*Morang elaichi* ; MAR.—*Veldoda*.

A herb, 2–3′ high, indigenous to East Bengal and Assam and distributed to surrounding areas. It is cultivated in the wetter districts of Bengal and Assam, at the foot of the Himalayas. The fruits are produced on pendant spikes. They are narrowly obovoid (1·5″ long) and 3 valved, with numerous seeds in each cell.

The seeds are used as spice and are medicinal. They yield about 1–1·2% of oil (sp. gr., 0·92 ; $[\alpha]_D$ —13°) containing a large quantity of cineol. This oil does not possess the characteristic odour of cardamom (Parry, I, 105 ; Wehmer, I, 183).

A. subulatum Roxb. GREATER OR NEPAL CARDAMOM

D. E.P., I, 222 ; Fl. Br. Ind., VI, 240 ; Kirt. & Basu, Pl. 942 ; Pl. XII, 3.

BENG.—*Bara elachi* (Large cardamom).

This species is cultivated in swampy places along the sides of mountain streams, in Nepal, Bengal, Sikkim and Assam.

The dark red-brown globose capsules (1″ long) contain several seeds in each cell, held together by a viscid sugary pulp. The seeds possess properties similar to those of true cardamom for which they are often substituted. They are used in the preparation of sweetmeats. In medicine, they are fragrant adjuncts to other stimulants, bitters and purgatives (Chopra, 137). An oil extracted from them is applied to eyelids to allay inflammation (Kanny Lall Dey, 24).

AMOORA Roxb. MELIACEAE

A genus of evergreen trees, comprising about 25 species, distributed mainly in the Indo-Malayan region. About a dozen species are found in India.

A. rohituka, see **Aphanamixis polystachya**

A. wallichii King = *A. spectabilis* Miq.

D. E. P., I, 225 ; Fl. Br. Ind., I, 561.

HIND.—*Lalchini* ; ASSAM—*Amari, bhoto-mayna* ; TRADE—Amari.

A moderate-sized tree with a straight, cylindrical bole, normally 20′ in length and up to 6–12′ in girth, with a dense spreading crown. It is found scattered in the evergreen forests of Sikkim, Assam and the Andamans.

It is a pale red to reddish-brown, light wood (sp. gr., 0·52 ; air-dry wt., 33 lb. per c. ft.), with a straight even-grained and medium texture. It is easy to saw, finishes to a fine smooth surface, and takes a good polish. The timber seasons well, when logs are converted green and open-stacked under cover (Pearson and Brown, I, 253). The timber is employed in Assam for boat-building and railway carriages. It is suitable for furniture and plyboards.

An allied species, *A. cucullata* Roxb., occurring in the tidal forests of Bengal and Burma, is used for posts and firewood.

AMORPHOPHALLUS Blume ARACEAE

A genus of 90 species of perennial or annual herbs, generally bearing one broad, long petioled leaf. They are indigenous to tropical Asia and Africa, and 14 species occur in India.

A few species like *A. campanulatus*, and *A. rivieri* Dur. (in China) are cultivated for their edible corms. Their acrid and irritating taste when fresh is due to crystals of calcium oxalate.

A. campanulatus Blume

D. E. P., I, 225 ; C. P., 65 ; Fl. Br. Ind., VI, 513 ; Pl. XI, 4.

SANS.—*Arsaghna, balukand* ; PERS. & HIND.—*Zamin-kand* ; BENG.—*Ol* ; GUJ. & MAR.—*Suran* ; TEL.—*Kanda* ; TAM.—*Karnai-kilangu* ; KAN.—*Suvarna gadde* ; MAL.—*Chena*.

This is a stout herbaceous plant, with an underground corm which is hemispherical and depressed, 8–10″ in diameter and of a dull-brown colour. It bears a large solitary mottled leaf on a long petiole.

There are several wild and cultivated varieties. Var. *blumei* Prain, known in Bombay as *ol*, is also recognised.

A. campanulatus is cultivated throughout the plains of India and Ceylon. The tuberous outgrowths from the fully developed corms are planted during May–June. They can be dug out for use, usually after 12 months, and they weigh 4–8 lb. each. Corms weighing 10–20 lb. are reported from Bombay. They keep well for a long period if stored dry in a well-ventilated room.

The corms of wild plants are highly irritant on account of the presence of crystals of calcium oxalate. In cultivated plants these are less abundant.

The corms are used for edible purposes (curries and pickles), only after long washing and prolonged cooking. They are also reported to be employed in certain Ayurvedic preparations recommended for piles and dysentery (Koman, 1920, 30 and 36).

The corm contains: moisture, 78·7; protein, 1·2; fat, $<$0·1; carbohydrates, 18·4; mineral matter, 0·8; Ca, 0·05; P, 0·02%; Fe, 0·4 mg; vitamin A, 434 I. U.; vitamin B_1, 20 I. U./100 g. (*Hlth. Bull.*, No. 23, 1941, 31). The yield of starch is less than 4·4% (Reantaso, *Philip. Agric.*, 1935, **24**, 239). The tender petioles also are edible. In the Philippines, pigs are fed on boiled corms and older shoots.

AMPHICOME Royle — BIGNONIACEAE

Fl. Br. Ind., IV, 385.

The genus contains 2 west Himalayan species of showy flowered herbs, occurring at about 7,000′. *A. emodi* Lindl. is said to be used as a febrifuge and as a substitute for chirata (Chopra, 461). The roots and leaves contain amorphous alkaloids and the leaves, a white neutral crystalline substance of m.p., 256–258° (*For. Res. India & Burma*, 1940-41, Pt. I, 108).

AMPHILOPHIS Nash — GRAMINEAE

Fl. Br. Ind., VII, 177.

A genus of about 8 species of grasses common in Asia, Africa, S. Europe, Australia and America.

A. odorata A. Camus (syn. *Andropogon odoratus* Lisboa) an aromatic grass 3–4′ in height is found abundantly in the neighbourhood of Bombay and in the Deccan. It is similar to *Bothriochloa intermedia* (Hole, *Annu. Rep., Bd. sci. Adv. India*, 1911-12, 117). The plant has a smell resembling that of ginger, and yields 0·3% of volatile oil (Wehmer, I, 113).

ANACARDIUM Linn. — ANACARDIACEAE

A small genus of about 8 species, indigenous to South America, whence *A. occidentale* has been introduced into India.

A. occidentale Linn. — CASHEW NUT TREE

D. E. P., I, 232; C.P., 65; Fl. Br. Ind., II, 20; Pl. I.

BENG.—*Hijli-badam*; HIND. & MAR.—*Kaju*; TEL. *Jidi-mamidi, muntha-mamidi*; TAM.—*Mindiri*; KAN.—*Geru bija*; MAL.—*Andi paruppu.*

An erect, spreading evergreen tree, growing up to a height of 40′ with a rough bark and a curious fruit. Its fleshy portion, known as 'Cashew apple', is really the swollen peduncle and disk, while the fruit proper is the kidney-shaped nut attached to it. The apple, 2–3½″ in length, has a thin, bright yellow or scarlet skin, and its flesh is soft and juicy. The drupaceous nut is greenish grey. The oleaginous shell or pericarp is hard, smooth and shining. It is thick and cellular and contains an acrid, oily juice which is powerfully vesicant. It encloses a slightly curved white kernel (about 30% of the nut) covered by a thin, reddish brown skin or testa.

This tree is common in tropical America, from Mexico to Peru and Brazil. It was introduced into India from Brazil, by the Portuguese some 400 years ago, and has become naturalised in the West Coast. It is also cultivated in the coastal regions of South Africa, Madagascar, Mozambique, the West Indies, and is found in south east Asia from Ceylon to the Philippine Islands.

CULTIVATION

More than 70% of the cashew nut production of India is from the West Coast, Ratnagiri and North Kanara dists. in Bombay, Goa, South Kanara and Malabar dists. in Madras, Cochin and Travancore. Cultivation has been greatly extended in these areas during the last two decades owing to the heavy demand for kernels in American and other foreign markets. The tree has also been

introduced into Bengal (Midnapore), Orissa (Puri, Ganjam, and Balasore) and Mysore.

A. occidentale is a hardy and drought resistant plant, but is very sensitive to frost. It thrives under a variety of soil and climatic conditions but sandy places are best suited to it. In India, it grows on laterite soils on the West Coast, with an annual rainfall of 120–150″ and does equally well on sandy soils of the East Coast, having a rainfall of only about 35″. It is generally grown on low hilly ridges, which are too dry and stony for other crops. More recently, owing to the expansion of the export trade in the kernels, plantations are being raised.

The tree is usually grown from seed, and it can also be propagated by grafting and layering, but much care is not taken in its cultivation. According to Paul (*Trop. Agriculturist*, 1936, **87**, 166), the ryots in South Kanara and Ceylon generally scrape the soil in the middle of some bush on hill-slopes and plant a few nuts, after the first few rains of the monsoon. After germination, the vigorous seedlings are retained and are not given any further attention. Manuring is not practised, though the tree responds to it by better development and increased yield of fruits. Generally nurseries are not opened, as the tap-root of the seedlings gets damaged during transplanting. In some parts of Ceylon and Malabar the nuts are sown in palmyra baskets, and after about a month, the seedlings with the baskets intact, are planted out about 30–40′ apart. The optimum number of trees is about 100 per acre, but it varies from 50–200 in the West Coast.

The tree starts bearing from the third or the fourth year, but full bearing capacity is attained at the 10th year and continues for another 20 years. The tree begins to flower in December and the flowering continues for about three months. It generally takes 2–3 months before the fruits are ripe enough to be gathered, and only the mature ones are collected before they fully ripen and fall to the ground. The season for collection extends from the end of February to the end of May or early June. A fully developed tree is capable of yielding 100 lb. of nuts per annum. In the West Coast, the average yield per tree is about 20 lb., in the eastern districts of Madras, 30 lb. and in Orissa, about 40 lb.

CASHEW NUTS

In certain areas of Madras (Panruti, Nellore, Kasargod, etc.) the nuts are thoroughly dried in the sun and shelled without roasting. But the proportion of nuts thus cracked does not exceed 5% of total production, as kernels from the roasted nuts are preferred. The roasting of the nuts is a delicate operation and adds to the flavour and taste of the kernels. A slight under-roasting or over-roasting adversely affects both the quality and the recovery of the kernels. Care has to be taken that the spurting shell oil, which is highly vesicant, and fumes from burning nuts do not affect the health of workers. Formerly roasting used to be carried out in shallow iron pans over a direct fire, with constant stirring to ensure uniform roasting, and all the oil in the shell used to be lost. Important economic uses having been found for the shell oil, small producers started using perforated earthenware pans for roasting, and to collect the exuded oil in receptacles placed underneath the pans. By this method only a small proportion of the oil in the shells (ca. 50%) is recovered. The larger processing concerns are now making use of perforated cylindrical rotary roasters. These are more hygienic and yield a larger proportion of the shell oil, but the loss of oil is still high.

Oil bath processes, aiming at quick and uniform roasting and higher recovery of oil, have recently been patented by some firms and are being worked by them. The nuts, held in wire trays, are passed through a bath consisting of cashew shell oil kept at 370–380°F., at a uniform rate (15′ in 80–90 seconds). Owing to the high temperature and the presence of a little moisture (7–8%), the oil-bearing cells of the shell burst and the exuded oil passes into the bath; at the same time, the nuts are roasted to the desired degree. The recovery of shell oil is higher and the residual oil in the broken shells is only about 10–15%. Recently, the use of superheated steam (500–700°F. at 5–20 lb. pressure) has been suggested for extracting the oil from uncracked shells, and for recovering the residual oil in broken shells obtained in the oil bath process (*Bull. imp. Inst., Lond.*, 1946, **44**, 17).

After roasting, the nuts are broken and shelled. In shelling, care is taken that the least possible amount of " brokens " is obtained. A small proportion of unpeeled kernels is put on the

Indian market, as kernels with the reddish-brown skin or testa keep longer, and are cheaper. But for export the kernels are divested of testa. After peeling, the brokens are removed and marketed separately, and the wholes are graded according to market standards, based on their size and appearance. Kernels meant for export to foreign countries are packed in vacuum with or without carbon dioxide. Both shelling and peeling are done by hand and suitable machinery for these purposes is still to be developed.

The pre-War cost of processing, i.e. roasting, shelling and peeling, usually amounted to Rs. 4-2-0 per md. of 82 lb. The cost of grading, which is done by hand-picking and sieving, varied from 4 6 As. for 100 lb. and that of packing in vacuum was about Rs. 1-6-0 per case of 40 lb. It is reported that the cost of packing rose up to Rs. 7-8-0 per case in 1942.

The kernels possess pleasant taste and flavour. They are eaten either raw or fried, and are sometimes salted or sugared, and have found favour particularly in the U.S.A. as dessert. They are also used in large quantities by sweetmeat dealers and confectioners. They constitute a highly nutritious and concentrated food. Their composition is very similar to that of sweet almonds (*Prunus amygdalus*, q.v.). They contain: water, 5·9; proteins, 21·2; fats, 46·9; carbohydrates, 22·3; mineral matter, 2·4; Ca, 0·05; P, 0·45%; Fe, 5·00 mg. and cal. val., 596/100 g. (*Hlth. Bull.* No. 23, 1941, 35).

Patel, Sudborough and Watson (*J. Indian Inst. Sci.*, 1923, **6**, 114) give the following characteristics and composition of the fatty oil which forms 40–53% of the kernels: sp. gr./15°, 0·9155–0·9180; $n_D^{40°}$, 1·4623–1·4633; acid val., 2·2–8·2; sap. val., 180·0–190·6; iod. val., 80·8–89·0; unsap. matter, 0·41%. The oil consists mostly of the glycerides of oleic (73·8%), linoleic (7·7%), stearic and palmitic acids.

Georgi (*Malay agric. J.*, 1922, **10**, 301) has found that high pressure is necessary to extract the maximum quantity of oil from kernels. The residual cake is rich in albuminoids (33% in oil-free cake). The physical and chemical constants of the cashew kernel oil closely resemble those of almond oil, but there is a wide difference in the solidifying points of the fatty acids obtained from the two oils, and the former, according to the Imperial Institute, does not conform to the B.P. specifications for almond oil. Owing to the high price of the kernels it is not advantageous to make use of them as a source of edible oil.

Although cashew nuts are produced on a commercial scale in East Africa and Brazil, India is at present the only country where they are processed for marketing the kernels, and India meets 95% of the world demand for kernels. Home production not being sufficient, raw nuts from Africa and even from Brazil are imported into India for processing. About 75% of the kernels produced in India are exported, and only 25% are consumed in the country.

The international trade in cashew kernels has developed during the last two decades. Up to 1925, it did not exceed 50 tons, but in 1941, it was nearly 20,000 tons. During the triennium ending 1940-41, nearly 73,000 tons of nuts (including 28,000 tons imported from Africa) were processed in India, yielding about 18,700 tons of kernels per annum. The following table gives the exports of kernels from India:

Year	Qnty. (Tons)	Val. (Lakhs of Rs.)	Price per cwt. (Rs.)
'38-39	13,499	1,29	48
'39-40	12,848	1,24	48
'40-41	14,653	1,61	55
'41-42	19,923	2,09	53
'42-43	6,248	98	79
'43-44	4,548	1,38	152
'44-45	7,895	3,23	205
'45-46	12,059	5,72	237

The U.S.A. takes 80% of Indian exports. Canada, the United Kingdom, Australia, etc., take the rest.

CASHEW SHELL OIL

The commercial shell oil obtained by the roasting of cashew nuts is a dark brown viscous oil, easily soluble in most of the organic solvents. Although not a glyceride, it is a drying oil. With suitable driers, it gives a smooth, shining film of dark-brown colour. In India, the oil is employed as a waterproofing agent, and as a preservative in the painting of boats, fishing nets and light wood work. It is

only within recent years, mainly as a result of the investigations of Messrs. Harvey and Caplan, that the oil has attained technical importance, and America is now the chief buyer of the oil produced in India. The industrial applications of the shell oil are based upon its polymerization to a rubber-like material under the influence of acids, and on the formation of a wide range of condensation products with aldehydes. The latter are generally hard, infusible and extremely resistant to the action of chemicals such as acids and alkalis.

The shell oil is also distilled and polymerization products of the distillate or mixtures of distillate with other materials, have found their way into the composition of diverse products : insulating varnishes, type-writer rolls, oil- and acid-proof cold setting cements, industrial flooring tiles, and automobile brake linings. Processes have been patented for the use of the oil in the preparation of cement and adhesive ingredients, pigments for gums, inks, oilcloth, paints, varnishes, etc., and waterproofing paper and cardboard finishing reagents (Gregory, 1939, I, 158). Ajmani and Jatkar (*J. Indian Inst. Sci.*, 1944, **26A**, 11) have found that good baking enamels can be prepared by dissolving the resin, obtained by condensing the shell oil with formalin, in linseed or tung oil. The resin yields good varnishes with ester gum and drying oils.

The chief constituents of the oil in the shells are anacardic acid and cardol. The former, $C_{22}H_{32}O_3$, is an *ortho*-hydroxybenzoic acid with an unsaturated side chain, and $C_{15}H_{27}$ (Pillay, *J. Indian chem. Soc.*, 1935, **21**, 226). Cardol has been assigned the formula, $C_{32}H_{52}O_4$ and is considered to be a phenol. Anacardic acid is said to constitute 90% of the oil, and cardol, about 10% (*vide* Harvey and Caplan, *Industr. Engng. Chem.*, 1940, **32**, 1306).

Pillay (*loc. cit.*) found that a sample of pure anacardic acid melted at 23–25°. Ordinarily it is a light brown viscous oil (Sp. gr./30°, 1·002 ; $n_D^{30°}$, 1·5163), insoluble in water, but soluble in most of the organic solvents. It gives an intense violet colouration with alcoholic ferric chloride., Cardol is a yellowish or reddish oily substance which darkens on exposure. It is also insoluble in water, but soluble in organic solvents. It is a powerful vesicant and irritant. According to Patel and Patel (*J. Univ. Bombay*, 1936, **5**, ii,114) the iod. val. of cardol (d/29°, 0·9795) is 310, while that of anacardic acid is 210.

The commercial oil obtained by roasting the nuts differs appreciably from the oil originally present in the shells.*

	Country-rendered oil	Solvent-extracted oil from unroasted shells
d/26°	0·9623	1·0131
$n_D^{40°}$	1·5087	1·5163
Acid val.	18·8	107·0
Sap. val.	32·9	119·0
Iod. val.	328·0	296.0

* (Ittyerah, Joseph and Sudborough, *J. Indian Inst. Sci.* 1922, **5** A, 155).

The oil extracted from the roasted shells (d/29°, 0·9578 ; sap. val., 4·5 ; iod. val., 340) is similar to the oil that separates out during roasting (Patel and Patel, *J. Indian chem. Soc., Industr. & News Edn.*, 1938, **1**, 83).

According to Patel and Patel (*J. Univ. Bombay, loc. cit.*) the change produced in shell oil during the roasting of raw nuts is due mainly to the decomposition of anacardic acid, followed by polymerization or condensation, or by both. Harvey and Caplan (*loc. cit.*) have found that the oil obtained by the vacuum distillation of commercial shell oil is mostly composed of a single phenolic component (70%), with an unsaturated side chain in the meta position. This substance has been termed ' cardanol ', as it is presumably the decarboxylation product of anacardic acid. Cardanol gives condensation products with formaldehydes, is volatile with steam, and may be employed for the preparation of resins (*Bull. imp. Inst., Lond., loc. cit.*).

Wats and Bharucha (*Curr. Sci.*, 1937, **6**, 216) suggest the use of the shell oil as a mosquito larvicide. The addition of 5% of the oil to kerosene or high speed diesel oil has been found to increase greatly their activity in anti-mosquito measures. The juice of the shell is sometimes used as a vesicant and counter-irritant.

During the triennium ending 1940-41, India produced 18,700 tons of kernels per annum and since the proportion of the kernel to the oil contained in the shell is roughly 1 : 1, if all the oil had been extracted, the yield would have been about 18,000

tons per annum. But actual production in 1942, however, was about 1,500 tons. Thus there is considerable scope for expansion in the production of the shell oil by better organisation and improved methods of extraction.

During the triennium ending 1941-42, the annual export of oil averaged to 1,073 tons per annum, and it increased to 1,910 tons in 1942-43. In 1942 the American price for the shell oil, f.o.b. Cochin, was $ 475 per ton of 235 gal., or Rs. 1-15-3 per tin of 4 gal. (Rep. Marketing Cashew Nuts India, 1944, 28).

CASHEW APPLE

The cashew apple is soft and juicy. When tender, it is acidic and highly astringent, but when fully ripe, it is sweet and only slightly astringent. The fruit is edible and yields a delicious beverage. The juice is fermented and made into a wine, which retains the flavour of the fresh fruit. The cashew apple contains: moisture, 87·9; proteins, 0·2; fat, 0·1; carbohydrate, 11·6; mineral matter, 0·2; Ca, 0·01; P, 0·01%; Fe, 0·2 mg./100 g. (*Hlth. Bull.* No. 23, 1941, 38). Mittra (*Sci. & Cult.*, 1940, **6**, 186) has found it to be a rich source of vitamin C (261·5 mg./100 g.), and it also contains 0·09% of carotene.

Each tree on an average yields about 75 lb. of apples per annum, and annual production in India is of the order of 55 lakhs of maunds. But of this only a small proportion is at present used. According to Srinivasan (*J. Indian Inst. Sci.*, 1935, **17A**, 85) each cashew apple yields 20–25 c.c. of juice having 10·4% of total solids, of which 94% consist of sugars, mostly invert sugar (7% in the apple). In addition, there are tannins, acids, pigments, etc. The juice, however, does not keep well, but rapidly deteriorates unless sterilized by heat or treated with preservatives. The Department of Industries, Madras has suggested a method for the preparation of an edible syrup from cashew apple juice (*Curr. Sci.*, 1934-35, **3**, 627). The juice is first treated with slaked lime, which precipitates the undesirable constituents. After filtration through cloth and the addition of a little acid (acetic acid ?), the filtrate is concentrated in an open pan over a fire to about a sixth of the original volume. The syrup obtained is thick, golden yellow, and almost odourless. Five or six fruits are sufficient to give one ounce of syrup.

Since the raw juice is rich in sugar, it can also be employed for the production of alcohol. It is reported that a few years ago, before 1938, when prohibition was introduced in Bombay, the cashew apple juice was used for fermentation in the distilleries of Ratnagiri dist. (Bombay). The apple juice can also be converted into vinegar (Rama Ayyar, *Sci. Rep. agric. Res. Inst., Pusa*, 1930, 55). The natural acridity of the juice is reduced by the addition of 0·25% of common salt.

The peelings obtained during the preparation of the kernels for the market, containing small pieces of the kernel and the brown testa, constitute about 12% of the weight of the kernels. It is estimated that annually nearly 75,000 mds. or about 2,745 tons of peelings are produced, and these can be utilized as a wholesome poultry food. Joachim (*Trop. Agriculturist*, 1934, **87**, 22) has found them to contain: moisture, 8·1; proteins, 7·6; fat, 12·3; carbohydrates, 59·2; fibre, 11·0; and ash, 1·8%.

The tree yields a pale yellow to reddish gum, which exudes in stalactiform masses. It is partly soluble in water, the main portion swelling up into a jellylike mass. It is reported to possess insecticidal properties, and to be used in book-binding (*Bull. imp. Inst., Lond.*, 1916, **14**, 115). The bark contains: tannin, 9; and non-tans, 9%; and the leaves: tannin, 23; and non-tans, 18% (*Indian For. Leafl.*, No. 72, 1944, 4). The milky sap of the bark turns black on exposure to air and is used as an indelible ink for marking linen. The wood is of a reddish brown colour, fairly hard, and weighs 30–32 lb. per c. ft. In Ceylon and Burma, it is used for packing cases, for boat building, and for charcoal. In south India, the tree does well as underwood in palmyra groves; and it is important in coast dune reclamation (Gamble, 214).

ANADENDRUM Schott ARACEAE

Fl. Br. Ind., VI, 539.

A small genus of about 6 species of climbers distributed in the Indo-Malayan region, of which 4 species occur in India. The leaves and roots of *A. montanum* Schott are said to be used in Malaya as vegetable. The leaves are supposed to be useful in remittent fever (Burkill, I, 147).

ANAGALLIS Linn. PRIMULACEAE

A genus of slender annuals, including 25 species, distributed in the temperate zones. *A. arvensis* is the only species found in India.

A. arvensis Linn. PIMPERNEL

D. E. P., I, 235; Fl. Br. Ind., III, 506; Pl. XIV, 1.

HIND.—*Jonkh-mari.*

A small erect herb, with beautiful blue or red flowers, occurring over the greater part of India as a weed. The flowers close during cloudy weather.

It was formerly used in Europe for several cerebral affections. In India, it is reported to have been used to intoxicate fish and to expel leeches from the nostrils of cattle. It is said to be poisonous to dogs.

The plant contains two glucosidic saponins. The root on keeping develops the smell of valerian and contains cyclamin (Wehmer, II, 923).

ANAMIRTA Colebr. MENISPERMACEAE

The genus includes two or three species of shrubs distributed in India and Malaya.

A. cocculus Wight & Arn. Syn. *A. paniculata* Colebr. LEVANT BERRIES, FISH BERRIES

D. E. P., I, 235; Fl. Br. Ind., I, 98.

Indian names are derived from SANS.—*Kakamari.*

A large climbing shrub, with kidney-shaped drupes (2–3″) which turn red on ripening.

The plant is found in Orissa, Eastern Bengal, Khasia hills, Deccan (Cuddapah, Malabar and Mysore), Ceylon, Burma and Malaya.

The berries have been used in India to stupefy fish and to poison crows. Very small quantities are sufficient for this purpose. They have also been employed as cattle poison in Madras and Bombay (Venkatachalam, *Mon. Bull. Bangalore Cattle Soc.*, 1945, **4**, 47). They are highly toxic; 2·4 g. have proved fatal to man (Sollman, 239). The symptoms produced are colic pains, nausea, vomiting, tetanic convulsions and sometimes delirium. They are also used externally in indigenous medicine, and Koman (1920, 2) found the drug useful in some cases of ringworm.

The active principle of the seeds is picrotoxin, $C_{30}H_{34}O_{13}$, m.p., 203–204°. (about 1·5%), which can be extracted with alcohol (Clark, *J. Amer. chem. Soc.*, 1935, **57**, 111). It is intensely bitter, and is a strong convulsive poison and 20 mg. are toxic to human beings. It is easily separable into picrotoxinin, $C_{15}H_{16}O_6$, and picrotin, $C_{15}H_{18}O_7$. The seeds also contain cocculin or anamirtin $C_{19}H_{28}O_{10}$, a tasteless crystalline substance, and a fixed oil, 11–24% (Ylagan and Alfred, *Chem. Abstr.*, 1942, **32**, 2348, and Wehmer, I, 333).

The pericarp contains the alkaloids, menispermine and paramenispermine, both pharmacologically inactive (Henry, 366).

Picrotoxin has been used to a limited extent to control night-sweats in phthisis and, in the form of an ointment, to destroy pediculi. It is an effective antidote for poisoning by barbiturates, and morphine. But it has to be administered with great caution. Accidental overdoses are controlled by a slow intravenous injection of a soluble barbiturate such as sodium amytol. It is also useful in the convulsion treatment of schizophrenia (Martindale, I, 934).

The dried ripe fruits constitute the drug *Cocculus fructus* also called *Cocculus indicus.* The fruits are collected by villagers and are dried in the sun. They are exported chiefly from Bombay, Calcutta and Madras. In the West also, they were formerly used as fish poison, and for adulterating malt liquor. Now they are mainly employed for the extraction of picrotoxin.

ANANAS Mill. BROMELIACEAE

This is a small genus of five species of plants, native to tropical America. *A. comosus*, the polymorphic species is cultivated widely in tropical countries for its succulent fruit. Some varieties are ornamental.

A. comosus (Linn.) Merril Syn. *A. sativa* Schult. f. THE PINEAPPLE

D. E. P., I, 236; C.P., 66; Hill, Fig. 197.

MAL.—*Kazhudhachakka.* Other Indian names are derived from Ananas.

The pineapple plant is a perennial, erect herb, with a short stem bearing a rosette of leaves 2–3′ long, with prickly margins and spiny tips. The

fruit, which has a rough surface and a crown of small leaves, has succulent flesh of yellow to light orange colour.

The pineapple is indigenous to Brazil. It was introduced into India by about the middle of the 16th century. It is cultivated in Assam, Bengal and along the West Coast. Hawaii and Malaya are the largest pineapple producing countries. Central America, Australia and South Africa also are important centres of production.

There are nearly 90 varieties, which fall into 3 distinct groups: the Queen, the Cayenne and the Spanish. The Queen is a hardy plant, and is prolific. The fruit matures quickly and possesses good taste and flavour. The average weight is 3–4 lb. Smooth Cayenne which is popular in Hawaii and Australia is a good variety, but requires a high standard of cultivation. The fruit is large and weighs 5–6 lb. The Kew, also of the Cayenne group, produces large fruits suitable for canning. The Queen and the Kew varieties are popular in India.

Although the pineapple can be grown under a variety of climatic conditions, it thrives best in places having a mild and humid tropical climate. It is cosmopolitan in its water requirements. It flourishes best in places where the annual rainfall is about 50 inches, evenly distributed throughout the year. In drier tracts, irrigation is necessary. A mean annual temperature of 60–90°F. is ideal for its growth. Open, well-drained soils of the type of sandy loam, preferably with a gentle slope, are suitable. Water logging is detrimental to its growth.

Propagation is by means of suckers, slips and crowns. The suckers come to bearing in 15–20 months, while slips and crowns take nearly 2–2½ years. The rainy months of July and August are the best period for planting. There are different methods of planting. The double row system with 5′ spacing between rows and 1½–2′ between plants is, however, popular. Regular weeding and periodical thinning are necessary. Heavy manuring is common. Of the nutritive elements, potash and nitrogen are of greater importance to pineapple and are readily supplied by farm-yard manure and wood ash (*Bull. imp. Inst., Lond.*, 1916, **14**, 446). 600 lb. of a mixture of sulphate of ammonia, sulphate of potash and superphosphate (1 : 2 : 3), or 905 lb. of a mixture of neem or castor cake, bone-meal and wood ash (4 : 3 : 4) per acre are recommended (Sané, *Dep. Agric., U. P., Bull.*, No. 9, 1942, 8).

The fruit is ready for harvesting, when it shows a pale green colour on the eyes, or a tinge of yellow at the base. If picked under-ripe, the fruit does not develop full colour, taste or flavour. The yield varies from place to place, 40 tons per acre being the maximum in Hawaii. The average yield in other countries is only 6–10 tons (Hayes, 220).

The crop generally suffers serious damage on account of several insect pests and fungal diseases. In India, however, there are no records of insect pests but only of a few fungal diseases (Sané, *loc. cit*; Chowdhury, *Curr. Sci.*, 1946, **15**, 82).

After harvesting, the fruit is carefully graded according to size and maturity and packed in boxes or crates for transport. Mature green fruits keep well for about a month at 50–60°F. at 85–90% humidity (Rose, ex Hayes, 221). A large part of the crop is canned. Pineapple canning is an important industry in Hawaii and Singapore; in Hawaii alone nearly 200,000 tons are canned every year (Hayes, *loc. cit.*). The pineapple juice from the trimmings, after treatment with lime, is used for the canning syrup. The wastes from canning factories are converted either into pineapple bran, which is a valuable cattle food, or fermented into power alcohol.

Pineapple from the West Coast has been found to be suitable for canning. In some cases, however, the appearance of the canned fruit suffers slightly on account of the removal of the deep set eyes and the fibrous nature of the flesh. The trimmings can be converted into pineapple jam, or pineapple syrup of good taste and flavour. The syrup can be blended with other fruit juices to produce fruit beverages.

Pineapple juice from unripe fruits acts as a violent purgative and is also abortifacient and anthelmintic. The juice of ripe fruits is a diuretic. Fresh juice contains bromelin, an enzyme which aids digestion. This is destroyed on heating to 65° and above (Asenjo, *Chem. Abstr.*, 1940, **34**, 2069).

Cabbab and Soliven (*Philip. Agric.*, 1938, **26**, 644) give the following analysis of the fruit: edible portion, 65·7; refuse, 33·4; and juice, 19·2%.

1 ANAGALLIS ARVENSIS

2 ANDROGRAPHIS PANICULATA

3. ANISOMELES MALABARICA

They found the juice to contain 4·3% of total sugars. According to Johnson (ex Hayes, *loc. cit.*) the sugar content of the juice varies from 8–15% and the acid content from 0·3–0·9%. The fruit contains: moisture, 86·5; protein, 0·6; fat, 0·1; carbohydrates, 12·0; mineral matter, 0·5; Ca, 0·02; P, 0·01%; Fe, 0·9 mg.; vitamin A, 60 I. U.; vitamin C, 63 mg./100 g. (*Hlth. Bull.*, No. 23, 1941, 39). For a detailed analysis of the juice of the Queen variety of fruit, see Bodenstein (*Dep. Agric. Sci., Union S. Africa, Bull.*, 1936, **153**, 14).

A fibre can be extracted from pineapple leaves, in a yield of 50–60 lb. per ton. The fibre is durable and is not injured by water. It has a white shining appearance and is suitable for textiles. The cost of production is, however, high. If fibre is to be the main crop, the plants should be grown close together in partial shade to induce the development of long leaves. Two year old leaves are generally taken for extracting fibre. After removing the green tissue by scraping, the fibres are soaked in water for about six hours and then dried in the sun. These processes are repeated until the fibre is completely blanched. It is then combed and made into filaments (*Bull. imp. Inst., Lond.*, 1916, **14**, 456).

Pina, the delicate and expensive fabric of the Philippines, is made from this fibre. The waste material left during the extraction of fibre is suitable for making paper (*Bull. imp Inst., Lond., loc. cit.*).

ANAPHALIS DC. COMPOSITAE

Fl. Br. Ind., III, 279.

A genus of herbs or small shrubs, comprising 50 species, found in Asia, Europe and America. The leaves of *A. neelgerryana* DC. (Western Ghats and Nilgiri Hills) are said to be bruised and applied to cuts (Dymock, Warden & Hooper, II, 322).

ANCISTROCLADUS Wall. ANCISTROCLADACEAE

D. E. P., I, 239; Fl. Br. Ind., I, 299.

A genus of woody climbers, comprising 12 species, distributed in tropical Asia, the Malay Archipelago and West Africa. About 7 species occur in India. The roots of *A. extensus* Wall. (Burma and Malaya), are said to be used in dysentery and malaria (Burkill, I, 155). The bark and leaves of *A. hamatus* Prain (syn. *A. vahlii* Arn.), a species found in Ceylon, is reported to contain an unidentified poisonous alkaloid, toxic to frogs (Wehmer, II, 809). In the Andamans, its wood is used for arrows.

ANDRACHNE Linn. EUPHORBIACEAE

D. E. P., I, 239; Fl. Br. Ind., V, 283.

A genus of shrubs, including about 15 species, distributed in tropical and sub-tropical countries, of which 5 species occur in India. *A. decaisnei* Benth. contains 86·3 mg. HCN/100 g. when young, and 63·3 mg. when old, and is highly toxic to sheep (Curchward and Gurney, *Chem. Abstr.*, 1938, **32**, 8478). *A. cordifolia* Muell. Arg. found in central and western Himalayas is also poisonous to cattle.

ANDROGRAPHIS Wall. ACANTHACEAE

A genus of annual herbs or small shrubs, including about 40 species, distributed in the tropical Asia. 19 species occur in India, of which *A. paniculata* is medicinal.

A. paniculata Nees THE CREAT

D. E. P., I, 240; C.P., 69; Fl. Br. Ind., IV, 501; Pl. XIV, 2.

SANS.—*Kirata*; ARAB.—*Quasabhuva*; PERS.—*Naine-havandi*; HIND.—*Kirayat*; BENG.—*Kalmegh*; MAR.—*Oli-kiryata*; GUJ.—*Kariyatu*; TEL. & TAM.—*Nelavemu*; KAN.—*Nelaberu*; MAL.—*Nelavepu*.

A bitter annual herb, found in the plains throughout India and Ceylon.

The fresh juice of the leaves is mixed with spices such as cardamom, cloves, cinnamon, etc., dried and made into pills for use as a household remedy for the minor digestive ailments of children. Birdwood (64) recommends an infusion and tincture of the dried stems and roots for dyspepsia and influenza (see also Kanny Lall Dey, 27). The plant also enjoys considerable reputation as a febrifugo, alterative and bitter tonic, and is often used as a substitute for chiratta (*Swertia chirata*).

The Central Indigenous Drugs Comm. (2nd Rep., 1909, 4) found it to be of some value in dysentery and malaria. An extract is marketed.

The leaves contain a bitter, water-soluble lactone, andrographolid, $C_{20}H_{30}O_5$, m.p., 220° (yield, 1·5–2·5%), first isolated by Gorter in 1911 and later by Moktader and Sircar (*J. Indian chem. Soc.*, 1939, **16**, 333 ; cf. Bhaduri, *Amer. J. Pharm.*, 1914, **86**, 349).

ANDROPOGON Linn. GRAMINEAE

D. E. P., I, 241.

This is a genus of grasses, including about 100 species, distributed throughout the tropical regions. A few extend to the temperate parts of North America. Formerly, many other important grasses like *Cymbopogon*, *Sorghum*, *Vetiveria*, etc., were included in this genus.

A. pumilus Roxb. (Bor, *Indian For. Rec., New Series, Bot.*, 1941, **2**, 68, and Pl. 5), a gregarious annual grass hardly reaching a height of 2′, is found throughout India. It grows on moist soils, but is at home in dry or semi-dry tracts. The grass is considered good fodder and is eaten by cattle, green or dry. When cultivated, it grows taller and produces more foliage. *A. ascinodis* C. B. Clarke, a common grass in Burma, is eaten by cattle, when tender.

ANEMONE Linn. RANUNCULACEAE

D. E. P., I, 253 ; Fl. Br. Ind., I, 8.

A large genus of herbs, including about 120 species distributed in temperate regions, of which 15 occur in India. According to Stewart (2) the roots of *A. obtusiloba* D. Don (Kashmir to Sikkim) are mixed with milk and given internally for contusions, and used externally as a blister. *A. narcissiflora* Linn. (Kashmir) is said to be poisonous (Caius, *Bombay nat. Hist. Soc.*, 1937 **39**, 720).

ANETHUM Linn. UMBELLIFERAE

A genus of three species of herbs, two of which yield dill oil used in medicine. *A. graveolens* Linn. (syn. *Peucedanum graveolens* Linn.) is indigenous to S. Europe, and is cultivated in England, Germany, Rumania and the Mediterranean region. *A. sowa*, the Indian species, is sometimes regarded as a variety of *A. graveolens*.

A. sowa Kurz Syn. *Peucedanum graveolens* Linn. (in part). DILL

D. E. P., VI, Pt. 1, 181 ; Fl. Br. Ind., II, 709.

SANS.—*Satapushpi* ; HIND. & BENG.—*Sowa* ; GUJ.—*Surra* ; TAM.—*Sata kuppi* ; KAN.—*Sabsige*.

A herb 1–3′ high, with pinnately divided leaves, found throughout India, and it is often cultivated. Its fruits are longer than those of the European species, and their dorsal ridges are paler in colour.

A. sowa is cultivated as a cold weather crop. The green herb is used as a pot-herb and as a flavouring agent. The seeds are well known for their medicinal properties, mostly due to the essential oil in them. They enter into the composition of various indigenous medicinal preparations. The essential oil, dill oil, or its emulsion in water, dill water, is considered to be an aromatic carminative, specially useful in the flatulence of children (Kanny Lal Dey, 233). Its seeds are also used as condiment.

Pharmacopoeial dill oil from *A. graveolens* is used as an aromatic carminative, in the flatulence of children. Dill oil is also used as a soap perfume. The oil from *A. sowa* has a higher sp. gr., lower rotation and lower carvone content.

Sowa seeds yield 3–3·5% of an essential oil, part of which being heavier than water, sinks in the receiver during distillation. The heavier fraction, boiling between 230–285° consists chiefly of dill-apiol $C_{12}H_{14}O_4$, which is isomeric with parsley apiol. After removal of this constituent, it approaches the pharmacopoeial oil in density and rotation, but has a lower carvone content.

CONSTANTS OF DILL OILS

	Whole dill oil (Bangalore).*	Apiol-free dill oil (Baroda)*	B.P. dill oil
Sp. gr./15°	0·9785	0·9030	0·900 – 0·9150
$n_D^{25°}$	14·943	1·4792	1·4810–1·4920 (at 20°)
$[\alpha]_D^{25°}$	+47·6°	+63·6°	+70 – +80°
Carvone content (sodium bisulphite absorption)	19·5%	18·0%	43–63%
Solubility in 80% alcohol	Soluble in 3 vols.		Should dissolve in 10 vols.

* Rao, Sudburough & Watson, *J. Indian Inst. Sci.*, 1925, **8A**, 183 ; see also Malaviya and Dutt, *Proc. Indian Acad. Sci.*, 1941, **12A**, 251.

The dried residue left after the distillation of the essential oil from the seeds of *A. graveolens* contains: fat, 16·8; protein, 15·1%. It may be used as cattle feed (Winton and Winton, IV, 423).

The *Sowa* herb yields 0·06% of an essential oil, which has a high proportion of terpenes (α-phellandrene), but no carvone (Malaviya and Dutt, *loc. cit.*). The European and American dill herb oils contain both carvone and d-α-phellandrene, although the carvone content (about 20%) is much lower than that of the seed oil (Wehmer, II, 897).

ANGELICA Linn. UMBELLIFERAE

D. E. P., I, 254.

A genus of aromatic herbs, including about 70 species, distributed in the north temperate regions and New Zealand. Two species occur in India.

A. archangelica Linn. Syn. *Archangelica officinalis* Hoffm.

Fl. Br. Ind., II, 707.

A stout aromatic perennial herb, 5–10′ tall, with small pale yellowish-brown fruits, found in Kashmir.

The stems, roots and fruits of the plant are used in the West for flavouring wines, liquors and confectionery. The dry root and rootstock (*Angelicae Radix*) and the fruits possess stimulant, expectorant and diaphoretic properties.

The dry rootstocks yield 0·35–1% (Wehmer, II, 887), and the fruits, 1·2–1·3% of essential oil (Guenther, *Chem. Abstr.*, 1931, **31**, 1951), the main constituent of which is β-phellandrene (Trustham, *Chem. Abstr.*, 1939, **33**, 5830).

The roots and fruits contain several furocoumarins, such as angelicin, bergapten, xanthotoxin, etc., in addition to umbelliprenin and some phenols (Späth and Pesta, *Chem. Abstr.*, 1934, **28**, 4720; and Späth and Vierhapper, *ibid.*, 1939, **33**, 2505).

A. glauca Edgew. (western Himalayas) is said to be a good cordial and stimulant and is used in flatulence and dyspepsia. The aromatic root is a flavouring agent.

ANISOCHILUS Wall. LABIATAE

D. E. P., I, 254; Fl. Br. Ind., IV, 627.

A genus of aromatic herbs or undershrubs, comprising 20 species, distributed in tropical Asia and Africa. About 13 species occur in India of which *A. carnosus* Wall. (western Himalayas, central and south India) is medicinal. The juice of fresh leaves is said to be cooling. Mixed with sugar-candy, it is a domestic remedy in the south for coughs and colds.

ANISOMELES R. Br. LABIATAE

A small genus of herbs or undershrubs, comprising about 6 species, distributed in the Indo-Malayan region, 4 of which occur in India.

A. malabarica R. Br. MALABAR CATMINT

D. E. P., I, 254; Fl. Br. Ind., IV, 673; Pl. XIV, 3.

MAR.—*Chodhara*; TEL.—*Moga-biraku*; TAM.—*Peyameratti*; KAN.—*Karitumbe*; MAL.—*Karithumba*.

A shrubby plant, 4–6′ high, with aromatic leaves, found in south India and Ceylon.

An infusion of the leaves has been found to be beneficial in dyspepsia and fever, accompanying teething in children (Koman, 1919, 12). A decoction of the plant, or the oil distilled from it, is said to be useful in rheumatism (Dymock, Warden & Hooper, III, 122).

The plant yields an essential oil (roots and stem, 0·005; leaves, 0·025 and flowers, 0·07%) containing citral (Rao and Majumdar, *Indian J. Pharm.*, 1945, **7**, 123).

A. indica (Linn.) Kuntze (syn. *A. ovata* R. Br.), found throughout India, is useful as an astringent and carminative.

ANISOPHYLLEA R. Br. RHIZOPHORACEAE

A. zeylanica Benth.

D. E. P., I, 255; Fl. Br. Ind., II, 442.

SINGH.—*Welliqnyanne*.

A small or medium-sized tree, with a slender stem, and finely scaled grey bark. It is peculiar to Ceylon and is fairly common in the wet zone up to 3,000′.

The wood is greyish brown and moderately hard. It is mottled with silvery white specks (wt., 45 lb per c. ft.). The timber is used for shingles, and will splinter, if not seasoned. It takes a good polish and is used for tea boxes, cabinets, etc. (Lewis, 180).

ANNONA Linn. ANNONACEAE

A large genus, comprising over 70 species of trees and shrubs, distributed in tropical America. A few are believed to be natives of Africa. Five or six species, some of which yield edible fruits, have been introduced into India, Burma and Ceylon. *A. squamosa* and *A. reticulata* are naturalized throughout the country.

A. cherimolia Mill. CHERIMOYER

D. E. P., I, 258; C.P., 71; Bailey, 1937, Figs. 903 & 904.

KAN.—*Hanuman phala.*

A small deciduous tree, 15–25′ high, cultivated from Peru to Mexico. Some trees are found on the hills of south India and Ceylon, but they are unsuited to the plains of north India. Cherimoyer readily hybridises with other species of *Annona*.

Its large fruits are said to be delicious and of an agreeable flavour (sugars, 18·4; proteins, 1·8; and fat, 0·1 per cent. Popenoe, 169).

A. muricata Linn. SOURSOP

D. E. P., I, 258; Talbot, I, 29; Bailey, 1937, Figs. 19 & 20.

MARH.—*Mamphal.*

A small, evergreen tree rarely more than 20′ high. It yields large fruits (3–6 lb.) which have spines. The tree is grown to a small extent in Assam and Burma and is occasionally found in south India and Ceylon.

The fibrous fruit has a juicy aromatic flesh (moisture, 81; total sugars, 12·7; protein; 0·4 per cent. Wehmer, I, 341). It is comparatively sour and contains two or three times as much acid as the custard apple, and somewhat less sugar. The tender fruit is used as a vegetable in Java (Hayes, 213). It is considered an anti-scorbutic (Burkill, I, 166).

The seeds are used as fish poison and possess insecticidal properties (Caius, *J. Bombay nat. Hist. Soc.*, 1938, **40**, 76). The leaves are reported to contain an essential oil (Burkill, *loc. cit.*).

A. reticulata Linn. BULLOCK'S HEART

D. E. P., I, 258; Fl. Br. Ind., I, 78; Pl. XV, 2.

BENG.—*Nona.* Other Indian names are derived from SANS.—*Ramphal.*

A small deciduous or semi-deciduous tree, 20–25′ high, bearing heart-shaped, yellowish red fruit, 3–5″ in diameter and up to 2 lb. in weight. It is completely naturalised in India.

The fruit is edible and the white pulp has the consistency of tallow and is somewhat insipid (moisture, 72·3; glucose, 12·5; proteins, 2 per cent. Wehmer, I, 341).

The unripe fruit is considered anthelmintic, the bark, a powerful astringent, and the leaves and seeds, insecticidal.

Santos (*Philip. J. Sci.*, 1930, **43**, 561; and 1932, **47**, 357) found in the bark 0·03% of an alkaloid *anonaine*, $C_{17}H_{17}O_3N$, m.p., 122–123°.

A. squamosa Linn. CUSTARD APPLE

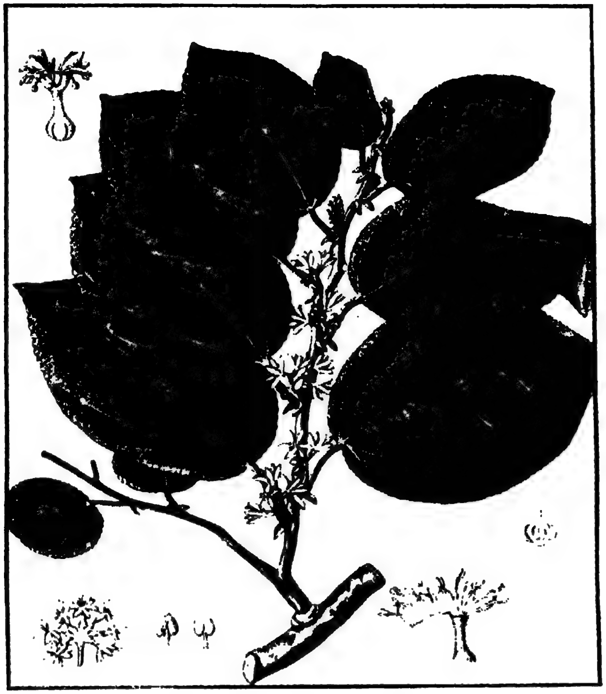
D. E. P., I, 259; C.P., 71; Fl. Br. Ind., I, 78; Pl. XV, 3.

ARAB., PERS. & HIND.—*Sharifa*; BENG.—*Ata*; Other Indian names are derived from SANS.—*Sitaphal.*

A small, more or less evergreen tree, 15–20′ high, bearing yellowish-green fruits 3–4″ in diameter. The flesh of the fruit is juicy, cream-yellow or white, delicately flavoured, and tastes sweet. The seeds are many, brownish-black, smooth, and oblong.

The tree occurs wild and is also cultivated all over India. The fruit has a pleasant flavour. It can be made into drinks, and fermented liquor. The pulp contains: moisture, 73·2; glucose, 14·5; saccharose, 1·7; and proteins, 0·8% (Wehmer, I, 340), and is said to be rich in vitamin C (*Curr. Sci.*, 1935, **3**, 553).

The unripe fruit, seed, leaf and root are considered medicinal and are used for destroying insects and lice. The seeds are also abortifacient. The root is a drastic purgative (Dymock, Warden



1. ANOGEISSUS LATIFOLIA

2. ANNONA RETICULATA

3. ANNONA SQUAMOSA

& Hooper, I, 45). The leaves are used as a poultice to produce suppuration.

Oven-dried kernels of seeds have been found to contain 30% of oil (sp. gr./15°, 0·9126 ; $n_D^{60°}$ 1·4558 ; sap. val. 188 ; and iod. val., 86. Ghanekar and Ayyar, *J. Indian Inst. Sci.*, 1927, **10A**, 28). Reyes and Santos (*Philip. J. Sci.*, 1931, **44**, 409) isolated from the bark *anonaine*, previously obtained from that of *A. reticulata* (q.v.). Fernando de Peralta (*Philip. Agric.*, 1928, **17**, 333) found hydrocyanic acid in the leaves bark and root, and traces of it in the wood and seeds.

The wood (wt., 46 lb. per c.ft.) is not of much value.

ANODENDRON A. DC. APOCYNACEAE

D. E. P., I, 255 ; Fl. Br. Ind. III, 668.

A genus of climbers, including 10 species, distributed in the Indo-Malayan region. 4 species occur in India. *1. paniculatum* A. DC. (Ceylon, Western Ghats, Assam and Burma) is a large climber and its stem is said to yield a strong fibre.

ANOGEISSUS Wall. COMBRETACEAE

A small genus of medium-sized trees, comprising 5 species, found in tropical Africa and Asia. Four species occur in India and Burma. The timber is valuable, and the bark and leaves contain tannin.

A. acuminata Wall.

D. E. P., I, 256 ; C. P., 71 ; Fl. Br. Ind., II, 450 ; Beddome, Pl. 16.

BENG.—*Chakwa* ; ORIYA—*Pasi* ; TEL.—*Panchman, pansi* ; TAM. *Nunnera* ; BURMA—*Yon* ; Trade—Yon.

A tall deciduous tree, with straight cylindrical trunk and drooping branches, bearing glabrous oval leaves. It attains a height of 30–40′ and a girth up to 7′. Bark is ½″ thick, rough and dark-grey.

It is found in the N. Circars, Chota Nagpur, Bihar, Orissa and Chittagong, and extends into Burma.

The tree is common in the teak forests of Burma. It is often met with along the banks of rivers on alluvial ground. Though it thrives in dry regions, it is a characteristic species of freshwater swamp forests in the plains.

It is a moderately heavy, irregularly-grained and fine-textured, whitish or pale greenish-grey wood (sp. gr., 0·8 ; air-dry wt., 51–55 lb. per c. ft.). Sapwood is light whitish-grey to pale greenish-grey, turning brownish with age. Heartwood is chocolate-brown, small, irregular and lustrous. It is anatomically featured by very inconspicuous growth rings, medium-sized to very small vessels borne solitary or in short radial rows, abundant parenchyma forming a narrow halo about the vessels, and very fine, close wood rays (Pearson and Brown, I, 544).

The wood is not liable to stain or insect attack. It is difficult to season owing to its tendency to warp and split. It is also liable to surface cracking. To reduce warping, converted timber should be carefully stacked and protected against rapid drying.

The timber is very strong and elastic. It is equal in hardness to *A. latifolia*, superior to it in transverse strength, in crushing at right angles to the grain, and in resistance to shear. It is hard and tough to saw ; but, with care, it works to a shiny, lustrous surface. It is extremely suitable for hammer, axe, and other tool handles, and, for this purpose, it can compete with imported hickory and ash.

Large supplies are available in the forests of Burma and Orissa. Burma quotes about Rs. 50 and upwards per ton for logs of an average girth of 5′, f.o.b. Rangoon (Trotter, 1944, 49).

A. latifolia Wall.

D. E. P., I, 256 ; C.P., 70 ; Fl. Br. Ind., II, 450 ; Pl. IX, 3 & Pl. XV, 1.

HIND.—*Dhawa, dhaura* ; MAR.—*Dhaura* ; GUJ.—*Dhavdo* ; TEL.—*Chirimanu, yella maddi* ; TAM.—*Vellay naga* ; KAN.—*Dinduga* ; MAL.—*Marukinchiram*. Trade—Axle-wood.

A large or moderate-sized gregarious tree, with an erect trunk, rounded crown, and drooping branchlets bearing broad, oblong leaves. It attains a height of 60′, and a girth up to 6′ is not

uncommon. Bark is ¼" thick, smooth and whitish grey, with shallow, irregular depressions, caused by exfoliations. The deep red foliage is shed in February and the tree remains leafless until April-May. Flowering takes place during Sept.–Jan. and the fruits ripen during Dec.–March.

The tree is characteristic of dry deciduous forests and is common throughout India, except E. Bengal and Assam. It is found in the sub-Himalayan tract from the Ravi to Nepal, Bihar, Chota Nagpur, Central India and extends southwards to the drier regions of Ceylon. It ascends to 4,000' in the Himalayas, and the south Indian hills. The tree thrives in well-drained alluvial or diluvial soil.

Artificial reproduction is carried out by sowing seeds on well-irrigated raised beds. Seedlings can be transplanted without injury. Pearson (*Indian For.*, 1907, **33**, 231) finds that the seeds are usually sterile, but those produced after years of drought are more fertile. The tree coppices well and pollarding increases leaf crop.

The leaves and twigs are tanniferous. The leaves, especially the tender ones, are very rich in tannin and they can be used satisfactorily in light leather industry. Two samples of leaves, and a third, consisting of young leaves and twigs, mostly broken (called *Dhawa* sumac), were examined at the Imperial Institute, London (*Bull. imp. Inst., Lond.*, 1929, **27**, 452 ; *vide* also Tanning Materials of the British Empire, 1929, 81). The results are tabulated below :

	Leaves %	Leaves %	*Dhawa* sumac %
Tannin	32·9	32·2	38·5
Non-tans	10·0	11·0	13·8
Moisture	12·8	12·3	14·0
Tintometer readings			
Red	1·5	1·7	1·9
Yellow	4·9	5 0	6·5

The leaves have to be dried in the shade, but fermentation sets in rapidly, resulting in loss of tannin. The sun-dried leaves contain less tannin and more water soluble non-tannins (*Bull. imp. Inst., Lond.*, 1931, **29**, 137). A suitable method of drying has yet to be worked out.

The tannin penetrates rapidly and produces a satisfactory pale leather with a greenish tinge. But the leather becomes sensitive to light (*Bull. imp. Inst., Lond.*, 1929, **27**, 452). The leaves are not used in factories, but only in country tanneries.

The dry bark contains 10–15% tannin, and in combination with *avaram* (*Cassia auriculata*) gives satisfactory results (Tanning Materials of the British Empire, *loc. cit.*).

The tree yields a gum, which occurs in straw-coloured vermiform tears and dries without cracking. It is sometimes brown because of impurities. It is partially soluble in water forming a colourless mucilage, and possesses double the viscosity of acacia gum. It is chiefly built up of pentoses and galactose (Wehmer, I, 824).

It is a good substitute for gum arabic and is useful for pharmaceutical purposes (Martindale, I, 2). It is a constituent of 'Gum Ghatti' and is used for sizing paper and in calico-printing.

The wood is heavy, fine-textured and yellowish grey to grey in colour. The grains are shallowly interlocked (sp. gr., 0·94 ; air-dry wt., 57 62 lb. per c. ft.). Sapwood is yellowish-grey in young trees and yellowish-olive-grey in older ones. Heartwood is purplish-brown, small, irregular, lustrous and with a smooth feel. Anatomically this wood is very similar to that of *A. acuminata* but with smaller pores, more clearly defined bands of parenchyma, and narrower rays (Pearson and Brown, I, 541).

In seasoning and working qualities also, it resembles the timber of *A. acuminata*. It lends itself well to turnery, finishing to a smooth shining surface.

Axlewood is slightly inferior to *Yon*. It is esteemed for cart axles, shafts, poles, batons, agricultural implements and tool handles. It is suitable for construction purposes, furniture, boat-building, etc. It is a good fuel wood (cal. val. of moisture and ash-free heartwood, 4900 cals. *Indian For. Bull., New Series*, No. 79, 1932, 11). It also yields good charcoal. Its price varies from Rs. 50–75, per ton (Trotter, 1944, 46).

The 'tasar' silkworm is sometimes fed on its leaves.

A. pendula Edgew.

D. E. P., I, 258 ; C.P., 71 ; Fl. Br. Ind., II, 451.

RAJPUTANA—*Dhav, dhaukra, kala dhaura* ; GWALIOR—*Kardahi*,

A small gregarious tree, with a short crooked bole and slender drooping branches. It is rarely more than 20′ high and 2–3′ in girth.

It is essentially a tree of hot, dry regions and is found in Rajputana, Bundelkhand, the United Provinces, and SE. Punjab.

The wood is very heavy and pale greenish-grey in colour (sp. gr., 0·96; air-dry wt., 62 lb. per c. ft.). It is closely comparable to *A. latifolia* in structure, but with smaller, more numerous pores.

The timber is not durable. In seasoning and working qualities, it resembles the other species described. It is an exceptionally strong Indian wood and is the third toughest timber in the world (Limaye, *Indian For.*, 1935, **65**, 628). It is used for poles and rafters, and for making carts, tool handles, toys, etc. It is also used as fuel (cal. val. of moisture and ash-free heartwood, 4739 cals. *Indian For. Bull., New Series,* No. 79, *loc. cit.*).

ANTHEMIS Linn. COMPOSITAE

D. E. P., I, 264; Fl. Br. Ind., III, 312.

This is a genus of perennial aromatic herbs, comprising about 120 species, native to Europe and the Mediterranean regions. *A. nobilis* Linn. (Roman or True chamomile) is medicinal and is cultivated in western Europe. Its dried flower-heads are used as a stimulant, carminative and nervine tonic. An infusion called chamomile tea is a domestic remedy for indigestion. Chamomile contains a volatile oil (0·6–1·0%) which is blue when fresh.

A. cotula Linn. found in Baluchistan is sometimes used as an adulterant.

ANTHOCEPHALUS A. Rich. RUBIACEAE

A small genus of trees, comprising 3 species, distributed throughout the Indo-Malayan region.

A. cadamba Miq.

D. E. P., I, 265; Fl. Br. Ind., III, 23; Beddome, Pl. 35.

SANS., HIND., BENG., MAR. & GUJ.—*Kadamba*; TEL.—*Kadambamu*; TAM.—*Vellai-cadamba*; KAN.—*Kadawala*; MAL.—*Attutek*; BURMA—*Mau-lettan-she*. Trade—Kadam.

A large deciduous tree with a straight stem about 30′ high and girth up to 5–7′. The rounded crown bears drooping branches and yellow flowers in globose heads.

It is found in the sub-Himalayan tract from Nepal eastwards to Burma, and in the south in the Northern Circars and Western Ghats. It is common in moist deciduous forests and thrives best in well-drained alluvial soil. The tree grows rapidly in the first 6–8 years and attains its maximum size in about 20 years.

The wood is yellowish-white or cream coloured, even-textured and straight-grained. It is smooth, light (sp. gr., 0·53; air-dry wt., 34 lb. per c. ft.), and lustrous when first exposed. The wood is anatomically characterised by inconspicuous, wide growth rings, medium-sized or small vessels, and relatively conspicuous medullary rays which appear as flecks on the radial surface (Pearson and Brown, II, 621).

The timber is moderately strong (65–80% of the strength of teak) and is rather soft. It saws and works easily under tools, and peels readily on a rotatory veneer lathe. It can be seasoned easily without any cracking or warping. The timber, however, requires quick drying, as it is susceptible to fungal attack causing sap-stain. It is not durable in the open, but is moderately so under cover. It can be treated easily, when it may be used in exposed positions. Untreated timber is attacked by white-ants and fungi.

Kadam is chiefly employed for cheap boarding and for packing cases and tea boxes. It is also used for beams and rafters and light construction work. It is suitable for dugouts, canoes, carving and turnery, and it is used for these purposes in Chittagong. In Burma, it is used in the match industry, for splints and boards (Pearson and Brown, *loc. cit.*). According to Sindall, the pulp obtained from the wood is suitable for cheap paper (Rodger, 81).

Assam (350 tons) and the Andamans (250 tons) provide a fairly steady annual supply of *Kadam*. Smaller quantities are available in Bengal and Burma. Assam quotes Rs. 28 per ton in logs (1937) and Bengal, Rs. 18–30 (Trotter, 1944, 51).

ANTIARIS Lesch. MORACEAE

Antiaris is a small genus of 5–6 species, distributed in tropical Asia. The bark is fibrous,

and the latex, generally, poisonous. Only one species, *A. toxicaria*, occurs in India.

A. toxicaria Lesch. THE UPAS TREE

D. E. P., I, 266; C. P., 71; Fl. Br. Ind., V, 537; Brandis, Fig. 190.

MAR.—*Karwat*; TAM. & MAL.—*Nettavil*; KAN. —*Ajjanapatte*; BURMA—*Hymaseik*.

It is a huge evergreen tree of the forests of the Western Ghats, growing up to a height of 250′. It also occurs in Ceylon, Burma, the Malay Peninsula and the East Indies. Its fruits are of the size of figs, and are single-seeded.

When the stem is pierced, a milky viscous sap exudes. It is bitter and biting in taste. When dried, it is of the consistency of a thick, dark brown resinous gum. This is the celebrated arrow-poison 'Upas antiaris' or 'Upas ipoh' of Java, Malaya and Burma. But the poisonous properties of the tree do not appear to have been known in the Deccan and Ceylon.

Chopra and Dey (*Indian J. med. Res.*, 1934, **21**, 513) have studied the pharmacological action of the sap. 7·5 mg. of water soluble extract per kg. of body wt. proved fatal to a cat in about half an hour. In small quantities, the juice is a mild cardiac and circulatory stimulant, and in large doses acts as a myocardial poison. It stimulates intestinal and uterine contractions. The latex proves fatal only when it reaches the blood stream, and it can be taken orally without any evil effect (Burkill, I, 182). It is not toxic to fowls. According to Ridley (*Chem. Abstr.*, 1930, **24**, 4683) it did not prove injurious to dogs when injected into the abdominal wall.

The active principle of the drug is a glucoside, said to occur in two crystalline forms: α and β 'antiarins' $C_{27}H_{40}O_{11}$. It possesses a strong digitalis-like action on the heart. The glucoside content varies considerably in different samples. An amorphous body, γ antiarin, with similar toxic effects, has also been isolated (Kiliani, *Chem. Abstr.*, 1911, **5**, 1283; and *ib.*, 1913, **7**, 1717, 3328. See also Wehmer, I, 243). Recently α antiarin has been found to be slightly less active than the β compound (*Chem Abstr.*, 1937, **31**, 3995; and *ib.*, 1942, **36**, 2921).

The inner bark yields a strong fibre. Large cylindrical pieces of the bark are stripped, soaked in water, and beaten till the fibre separates in the form of a white felt. In southern India, the fibre is used to make sacks, and hence the tree has come to be known as the 'sacking tree'. In Borneo and Malaya, a kind of cloth is made out of the bark. But this fabric proves injurious to the body because traces of latex adhering to it react on the skin. The fibre is also considered good for cordage and matting.

The bitter seeds are said to be used in the Konkan and in Canara as a febrifuge and in dysentery (Dymock, Warden & Hooper, III, 349).

The wood is soft, white and even-grained; wt., 24 lb. per c. ft. (Gamble, 651).

ANTIDESMA Linn. EUPHORBIACEAE

A genus of small trees, comprising about 150 species, distributed in palaeotropical regions. About 25 species occur in India, of which *A. bunius* and *A. ghesaembilla* are of some importance. *A. diandrum* Roth and *A. menasu* Miq. ex Tul. also yield timber of minor importance.

The fruits of *Antidesma* are edible.

A. bunius Spreng.

D. E. P., I, 269; Fl. Br. Ind., V, 358.

MAR.—*Amati*; TEL.—*Anepu*; TAM.—*Nolaiali*; NEPAL.—*Himalcheri*; LEPCHA—*Kantjer*.

A small evergreen tree, found throughout the hotter parts of India, particularly on the lower Himalayas, Konkan, Ceylon and Tenasserim. It is grown for its edible fruits, which are small, ovoid, and dark-red to black in colour.

The bark is poisonous and is said to contain an alkaloid. The wood (wt., 46 lb. per c. ft.) is similar in appearance to that of *A. ghesaembilla*. The pulp obtained from it can be used for cardboards (Burkill, I, 185).

A. ghesaembilla Gaertn.

D. E. P., I, 270; Fl. Br. Ind., V, 357.

HIND. & PUNJ.—*Umtao*; BENG.—*Khudi jamb*, TEL.—*Janupulisaru*; KAN.—*Pullampurasi gida*.

A tree about 40′ high, widely distributed in tropical Himalayas from Simla to Bhutan, in Konkan, North Kanara and Ceylon.

The fruit, a dark purple berry with a pleasant sub-acid taste, is edible. In the Malay Peninsula, the leaves are used as an acid-flavouring to food

(Burkill, *loc. cit.*, 186). The wood is red, with a darker-coloured heartwood, smooth, hard, and close-grained (wt., 49 lb. per c. ft.).

ANTIMONY ORES

D. E. P., I, 270; C. P., 72.

Stibnite: SANS.—*Anjanam*; ARAB.—*Ismad, kohal*; PERS. & HIND.—*Surmah*; BENG.—*Shurma*; GUJ.—*Surmo*; TAM., TEL. & KAN.—*Anjana*.

The chief ore of antimony occurring in India and Burma is stibnite, also known as antimonite Sb_2S_3 (Sb, 71·4%; sp. gr., 4·57; H., 2). It is sometimes coated with a thin layer of its alteration products (oxides etc.) such as valentinite, cervantite, stibiconite, kermisite, etc. The sulphantimonites, jamesonite and zinckenite composed of antimony and lead sulphides occur in Chitral.

Stibnite is a lead-grey mineral with a metallic lustre, sometimes showing iridescence on the surface. It fuses easily in a candle flame. Stibnite occurs in masses of radiating crystals which have columnar or bladed habit. The mineral, ground into a fine powder, is much used in northern India as a cosmetic preparation for the eyes. It is regarded as having a cooling effect. Stibnite is converted into metallic antimony (q.v.), which finds a wide range of applications in the form of its alloys and compounds.

Antimony ores occur in deposits associated with volcanic rocks, but are more common in veins containing small proportions of other sulphides like galena, zinc blende, etc. Quartz is the most common gangue mineral, but stibnite may also be associated with dolomite, calcite and barite. Antimony-bearing veins are generally found to be rich only to a moderate depth below the surface, but auriferous stibnite quartz veins extend to greater depths than pure stibnite veins.

DISTRIBUTION

The following are the important occurrences of stibnite in India and Burma:

Burma: In Amherst dist. large deposits of antimony ore occur in slaty formation as lenticular masses in veins, composed of brecciated calcareous chert about 9 miles S. of Thabyu (15°36′: 98°30′), near the border of Siam (Thailand). The biggest lode has been followed for more than 600′ and has a thickness of at least 20′. The ore (Sb, 60·5–61·6%) consists of masses of stibnite (crystals up to 4–5″ in length) which have been converted to a depth of several inches from their outer surface, to earthy antimony ochres, cervantite or stibiconite, and contains only traces of arsenic. Antimony is also said to occur at Guangde (Quangadu, 16°33′: 97°38′) on the north bank of the Salween, opposite Moulmein; and at Lekka Taung, 23 miles S. of Moulmein.

In the Southern Shan States, deposits of stibnite, occasionally covered with thin crusts of valentinite and cervantite, occur near Naking (21°45′: 98°14′), Loi Hke (21°39′: 98°21′), Mong-Ing (21°7′: 99°21′), Hkomhpok (21°46′: 97°49′) and Loihsang (21°53′: 97°38′). The deposit near Naking is the largest and about 1,000 tons of ore were extracted from this area in 1908. The average percentage of antimony in ore of this locality is 35·6. Old workings of stibnite occur south of Mene-taung village (20°59′: 96°37′).

Antimony ore (stibnite) occurs with wolfram and bismuthinite in Paungdaw (14°1′: 98°33′) and at Zinba (14°38′: 98°11′) in Tavoy dist. Stibnite also occurs in the quartz veins in Thaton and Mergui dists. Promising deposits of stibnite occur in quartz reefs near Lebyin (20°40′: 96°29′) in Meiktila dist. The quality of stibnite is good (Sb, 51·2%) and the ore contains 0·06 oz. of silver per long ton (*Rec. geol. Surv. India*, 1942, **77**, *Prof. paper* No. 10,15).

Several sulphantimonites occur in minute quantities in the lead zinc ores of Bawdwin mines, and antimonial lead is obtained as a by-product in the lead refinery at the Nam Tu smelters of the Burma Corporation Ltd.

Mysore: In Chitaldrug dist. antimony ores (cervantite and stibnite) are found as stringers and patches in a quartz vein (9″–1·5′ thick) traversing the chloritic schists at Chikkonanhalli (14°24′: 76°43′). Later work has shown that this quartz vein contains antimony ores only up to a depth of 30″ from the surface.

North-West Frontier: Valuable deposits of stibnite (Sb, 30–40%) free from arsenic have been recently discovered near Shogor approximately 13 miles north of Chitral, the capital of Chitral state. The ore contains traces of lead and copper. The mines are located 7,500′ above sea-level and the

ore is dug out from quarries, handpicked, and transported to the nearest rail-head, Durgai, 175 miles away.

Jamesonite also occurs in Chitral, and zinckenite used to be mined at Shogor. An old mine of inferior grade antimony ore is said to exist in the Zaimukht hills, N. of Thal (33°22' : 70°35') in Kurram.

Punjab : Several lodes of antimony ore have been known to occur near the Shigri glacier (32°17' : 77°40') in Lahaul. The lodes occur as wide veins in gneissose granite at an elevation of 13,500" beyond the Hamta pass. The ore consists of stibnite, superficially altered into kermesite and cervantite, and has yielded 6 dwts. of gold per ton. Argentiferous galena and zinc blende are also found in the same locality. The mines can be worked only during three months in the year, and are estimated to yield 8–15 tons of ore per annum.

Minor occurrences of antimony ores are in Baluchistan (Shekran, 27°53' : 66°28'), Bihar (Hisatu, 24°0' : 85°1'), the Central Provinces (Sleemanabad), Hyderabad (Enchipilli, 18°37' : 80°24'), Madras (Jangamarajpalli, 14°46' : 78°57') and Rajputana (Taragarh lead mines).

MINING & PRODUCTION

Beneficiation of low-grade ores is attempted in regions where the ore contains valuable constituents other than antimony. Flotation appears to be the best concentration method, and differential flotation is suggested for the removal of arsenopyrite which would otherwise contaminate the metal produced. Antimony ores are soft and friable and produce much dust. This is one of the principal difficulties met with during concentration of ores (Liddell, 11, 136).

The quality of the ore depends upon its antimony content and is adversely affected by the presence of other elements like lead, copper, arsenic, bismuth and zinc. The last two should not be present except in traces (Halse, 21).

The world's annual production of metallic antimony is about 31,000 tons. China has long been the most important source of antimony, but production decreased since the outbreak of hostilities with Japan. In 1939, Bolivia was the most important producer, followed by China, Mexico and Yugoslavia (Bray, 40).

The production of antimony ores in India has been sporadic and small quantities have been obtained from the Shigri deposit of the Punjab (15 tons of stibnite in 1905), and Chitaldrug in Mysore State (135 tons of ore during 1917–19. Rama Rao, *Quart. J., geol. Soc., India,* 1942, **14,** 173). During 1937–38, 31 tons of zinckenite were mined at Shogor in Chitral. In recent years, the Chitral Mining Company have been extracting stibnite for the production of the metal at their works, the Star Metal Refinery, in Bombay. The production of ore in 1943 was 395 tons, and in 1944, 962 tons.

The output of antimony ore in Burma, in 1938, was 181 tons. But production of antimonial lead (Sb, 16–20%) at Nam Tu has been more regular. Since 1924, the average annual production has been of the order of 1,200 tons. This contains also small quantities of copper and silver and is exported to the U. K. and the U. S. A. for further treatment.

APHANAMIXIS Blume MELIACEAE

This genus has been recently separated from *Amoora* (q. v.) from which it differs in having unisexual flowers not borne on the same tree.

A. polystachya (Wall.) Parker Syn. *A. rohituka* Wight & Arn.

D. E. P., I, 224; Fl. Br. Ind., I, 559; Beddome, Pl. 132.

SANS.—*Rohituka*; HIND. *Harin-harra*; BENG. —*Tikataraj, pitta-raj*; MAR.—*Rohada*; TEL.— *Chawa-manu*; TAM.—*Malampuluvan*; KAN.— *Mullu munthala*; MAL. *Chemmaram*; BURMA— *Thitni*. Trade -Amoora.

A large evergreen tree, having a straight cylindrical trunk 50' long and 5–6' in girth, with a heavy crown. It is distributed in the sub-Himalayan tract, from Gonda (U. P.) eastwards to Bengal and Assam, and southwards to Burma and the Andamans. In south India, it is common in the Western Ghats from North Kanara downwards to Tinnevelly.

The wood is reddish when fresh, but gradually becomes reddish-brown. It is moderately heavy (sp. gr., 0·54–0·65; air-dry wt., 35 lb. per c. ft.), with a straight or sometimes interlocked grain and a coarse texture. The timber saws and works well, taking a smooth finish and good polish. The logs are converted green, kept under water, and

later stacked vertically. It is a durable timber under cover, and durability can be further increased by surface treatment with antiseptics (Pearson and Brown, I, 251).

It is used for dugouts, canoes, roof structures and light construction work. It may be used for plyboards (Pearson and Brown, *loc. cit.*).

The seeds contain 78% of kernels, which yield about 47% of a reddish-brown, semi-drying oil, with a bitter taste (sp. gr., 0·931 ; n^{ϵ} 1·48 ; sap. val., 186·0 ; iod. val., 134·5 ; acid val., 13·7 ; (Ayyar and Patwardhan, *J. Indian Inst. Sci.*, 1935, **18A**, 19 ; see also Deb, *Chem. Abstr.*, 1940, **34**, 3523).

The oil is used as liniment in rheumatism. The bark is astringent and is used in cases of enlarged glands, liver and spleen. But Koman did not find it beneficial (1919, 14).

APIUM Linn. UMBELLIFERAE

A genus of annual or perennial herbs, comprising about 40 species, found throughout temperate regions and in the mountainous areas of the tropics. *A. graveolens* is largely cultivated in Provence and Anjou (France) for its seeds, and throughout Europe and America as a salad crop. It is also cultivated in India.

A. graveolens Linn. CELERY

D. E. P., I, 271 ; C. P., 27 ; Fl. Br. Ind., II, 679 ; Kirt. & Basu, Pl. 478.

HIND.—*Shalari*, *Ajmud* ; BENG.—*Randhuni* · S. INDIA—*Ajmod* or *Ajmoda*.

Celery, cultivated as a salad crop or for seeds, is *A. graveolens* var. *dulce* DC. It is an erect herb, 2–3′ high, with conspicuously jointed stems bearing well developed leaves on long expanded petioles. The fruit is small (1–1 5 mm. long and 1 mm. in diameter) and contains a minute seed. The epicarp is interspersed with oil-ducts.

A. graveolens var. *rapaceum* DC., called celeriac, another cultivated variety, somewhat smaller in size, has dark-green foliage with less developed stalks and swollen roots, 2–2½″ in diameter. This is also called turnip-rooted celery, and its root is eaten after cooking.

In colder climates and on the hills, celery is a biennial plant and produces seeds only in the second year, but in the plains it becomes an annual and produces seeds in the very first year. It is a moisture-loving plant requiring a cool climate. It grows best on sandy and silt loams and is not suited to clayey soils. It is a somewhat exacting crop and requires a carefully prepared and heavily manured soil. During the period of growth, several dressings with fertilizers are necessary. It also requires plenty of water and arrangement should be made for frequent irrigation.

When grown as a garden crop on the hills, seeds are sown in March–April, seedlings are transplanted in May, and the crop is ready in November–December. In the plains, seedlings, preferably brought from the hills, are transplanted in September–October and the crop is ready in three months. Before harvesting, celery needs blanching by excluding light from the petioles. This is done, by banking up the crop with soil, for 2–3 weeks till only the leaf tops are left exposed. Blanching improves both the flavour and the tenderness. A few American varieties such as Giant Pascal ; and 'Golden Self-blanching' are specially suited to commercial production.

In recent years, celery is being grown in the Punjab and the U. P. for its seed, which is exported to the U.S.A. Seeds (½–¾ lb. per acre) are sown from the middle of September to October and transplanting of seedlings into rows 2–2½′ apart is carried out in January. The crop is ready for harvesting by about the middle of May and the yield of seed (fruits) is about 8–9 maunds per acre (Purewal, 26).

Celery is liable to certain fungal diseases such as Early blight, Late blight and Bacterial blight, and to the attack of a number of common garden insects. Bordeaux mixture is recommended for the former, and dusting with sulphur and hydrated lime for the latter (Knott, 234).

In India, celery (leaves and stalks) is used as salad and in the preparation of soup, mostly by Europeans. The leaves of var. *rapaceum* contain : moisture, 81·3 ; carbohydrate, 8·6 ; fat, 0·6 ; protein, 6·0 ; Ca, 0·23 ; P, 0·14 % ; Fe, 6·3 mg. ; vitamin A, 5,800–7,500 I. U. and vitamin C, 62 mg./100 g. ; the stalks contain : moisture, 93·5 ; carbohydrate, 3·5 ; fat, 0·1 ; protein, 0·8 ; Ca, 0·03 ; P, 0·04 % ; Fe, 4·8 mg. ; vitamin A, nil and vitamin C, 6 mg./100 g. (*Hlth. Bull.*, No. 23, 1941, 29 and 32). Traces of copper and arsenic are reported in the tuberous root (moisture,

84%) whose food value appears to be very low. The herb is also reported to contain the glucoside, apiin (Wehmer, II, 876).

The celery fruits yield 2–3% of a pale yellow volatile oil with a persistent odour, characteristic of the plant. In trade, this is known as celery seed oil and is much valued both as a fixative and as an ingredient of novel perfumes. The oil has the following constants: sp. gr., 0·850–0·895; n_D, 1·478–1·486; $[\alpha]_D$, +65°–82°; acid val., up to 5; ester val., 15–40. The principal constituents are: *d*-limonene, 60; *d*-selinene, 10; sedanonic acid anhydride, 0·5; and sedanolide, 2·5–3%. The last two are responsible for the aroma of the oil (Finnemore, 644; and Wehmer, II, 876). The volatile oil from the green leaves (0·1%) is of no commercial importance.

The dried ripe fruits (celery seeds) are used as spice. They are stimulant and carminative and are used as nervine sedative and tonic. A domestic remedy for rheumatism is a decoction (1 in 20). The fruits also yield 17% of a fatty oil—oil of celery (Jamieson, 246). This is used as an antispasmodic and nerve stimulant. It has been successfully employed in rheumatoid arthritis and probably acts as an intestinal antiseptic (Martindale, I, 201). The root is considered alterative and diuretic and is given in anasarca and colic (Kanny Lall Dey, 33).

APONOGETON Linn. f. APONOGETONACEAE

D. E. P., I, 277; Fl. Br. Ind., VI, 564.

A small genus of aquatic plants, comprising 15 species, distributed in tropical Asia, Australia, and South Africa. About 4 species occur in India. The starchy rhizomes of *A. monostachyon* Linn. [= *A. natans* (Linn.) Engl. & Krause] found throughout India and Ceylon, and *A. crispum* Thunb. occurring in the Central and United Provinces, Bengal and Bihar are edible.

APOROSA Blume EUPHORBIACEAE

This genus of trees, 20–40′ high, includes about 75 species, distributed in the Indo-Malayan forests. 15 species are said to occur in India and about 10 in Burma.

The timber of some species is reported to be employed in the construction of houses. The best known of these is *A. dioica*.

According to Fl. Assam (IV, 164), a decoction of the leaves of *A. aurea* Hook.f. is used as a yellow dye. The bark of *A. frutescens* Blume, occurring from Tenasserim to Java, is reported to be used in Java for fixing the dye of *Morinda* spp. (Burkill, I, 195).

A. dioica Muell. Arg. Syn. *A. roxburghii* Baill

D. E. P., I, 278; Fl. Br. Ind., V, 347.

BENG.—*Kokra*; NEPAL—*Kagbhalai*.

An evergreen tree, distributed in the tropical forests of Chittagong and Pegu down to Tenasserim in Burma.

The dark brown wood is said to be very hard and close-grained.

A. lindleyana Baill.

Fl. Br. Ind., V, 349; Talbot, Fig. 501.

TAM.—*Vittil*; KAN.—*Salle*.

A small tree, found in the forests of the Konkan and N. Kanara, extending further southwards to Ceylon up to an elevation of 2,000′.

The wood is dull reddish-grey and smooth (wt., 38 lb. per c. ft.). In N. Kanara, it is used in the construction of houses, especially for rafters. The fruit is said to be edible (Gamble, 609).

A. villosa Baill.

D. E. P., I, 278; Fl. Br. Ind., V, 345.

BURMA—*Ye-mein* (for *Aporosa* species).

A deciduous tree, abundant in the *Eng* forests of Burma from Pegu to the Martaban hills and extending into the open forests of Indo-China.

The wood is usually reddish, fairly hard, even-grained, and of moderate weight. It is not used to any extent. The tree is said to yield a red resin.

AQUILARIA Lam. THYMELAEACEAE

The genus occurs in north-eastern India and Burma and extends through south east Asia to the Philippines. It comprises about 12–15 species, two of which occur in India. The important characteristic of this genus, like that of other members of the family, is its long bast fibre which makes several of the species useful for the manufacture of paper and cordage.

Some species (chiefly *A. agallocha*) contain patches of fragrant resinous wood, which enter into

trade under the name *Agar*. This has been prized from remote times in Egypt, Arabia and throughout the East for use as incense. It has also been used for making beads, rosaries and ornaments.

Agar is regarded as a pathological product formed as the result of a fungus disease, contracted by the tree chiefly through some wound or boring in the trunk. Bose (*Sci. & Cult.*, 1938, **4**, 89) has identified the fungus mycelium present in the cells of the diseased wood as belonging to the group *Fungi Imperfecti*. No fluid resin exudes naturally or on tapping the tree. Trotter (1940, 251) reports that it has now been proved possible to infect other trees by driving into them pegs from trees containing *agar* wood (see also Pearson and Brown, II, 859).

A. agallocha Roxb. ALOE-WOOD, EAGLE-WOOD

D. E. P., I, 279; Fl. Br. Ind., V, 199; Kirt. & Basu, Pl. 836.

SANS.—*Agaru*; HIND.—*Agar*; ASSAM—*Sasi*; BURMA—*Akyaw*. Other Indian names are derived from the Sanskrit name. Trade—Indian Eagle-wood.

It is a large evergreen tree over 60–70′ high and 5–8′ in girth with a moderately straight, and often fluted, stem. It is distributed only on the eastern side of India, and in Bhutan, parts of Bengal, and particularly in Assam on the hill forests of Khasia, Garo, Naga, Cachar, and Sylhet. In Burma it occurs on the Martaban hills of south Tenasserim.

The sound wood is soft, light and elastic (wt. of air-dried Burma wood, 25 lb. per c. ft.; Assam wood, 31 lb. per c. ft.). It is white to pale yellowish-white, and has no characteristic odour. Anatomically it is featured by the absence of growth rings, medium-sized to small vessels borne mostly in radial rows of 3–4, and numerous longitudinal interxylary strands of phloem consisting of soft bast and some fibres. The heartwood is not distinct.

It is somewhat liable to split during seasoning and is very liable to sapstain. The logs should be converted green and stacked in open piles under cover. It is easy to saw, but it cannot be brought to a good surface as the fibre is woolly. The wood is not durable, and is used for making bows by the Karens in Burma, and for walking sticks. It is a third class timber (Pearson and Brown, II, 859).

AGAR

Agar, which consists of irregular patches of dark wood highly charged with oleoresin, is found in the interior of comparatively old trees. The agar-bearing tree has a somewhat diseased appearance, and the oleoresin is usually found where the branches fork out from the stem. Professional agar-collectors among the *Garos* (a hill tribe) are able to spot out agar-bearing trees. However, the unskilled labour generally employed fells trees indiscriminately, and chops them into pieces to sort out *agar* wood. The tree has become scarce owing to this wasteful method of collection.

Agar is frequently found in young trees about 20 years old. But the disease takes some time to mature, and trees about fifty years old have the highest concentration (yield, 6–8 lb. per tree). Sometimes, all the tissues under the bark of the tree may be found converted into *agar* (Hooper, *Agric. Ledger*, 1904, **11**, 1).

True *agar* is heavier than water. This property is sometimes used in grading the wood; specimens not heavily loaded with resin float. *Agar* has a slightly bitter aromatic taste, and a peculiar agreeable odour comparable to that of sandal-wood or of ambergris. It burns with a bright flame or smoulders, giving off a pleasant smell.

Agar wood is highly charged with resinous matter, and contains 48% of alcohol soluble matter. After saponification of the alcoholic extract, benzyl acetone, another unidentified ketone, $C_{14}H_{20}O_2$, a sesquiterpene alcohol, and some acids (including hydrocinnamic acid) have been obtained. The sesquiterpene alcohol possesses the characteristic odour of the wood (Kafuku and Ichikawa, *Chem. Abstr.*, 1936, **30**, 240).

Agar is found in the market in the form of chips and splinters (fine quality), and also as blocks weighing about a pound. True *agar* is hard, brown, and rich in resin. It is prized mainly for burning as incense by the Parsees and Arabs. Sylhet *Agar* commands the highest price in the market. *Dhum*, a softer and yellowish-white variety is of comparatively inferior quality. It is used for distilling the volatile oil called *agar attar*, in Sylhet (Assam). The crude method of distillation adopted yields 0·75–2·5% of oil (De and Adhikari, *Indian For.*, 1927, **53**, 158).

In India, *agar* attar has been as highly prized as the otto of roses. According to Trotter (1940, 252), ' the oil is a valuable perfume retainer and is much prized by European perfumers for mixing with their best grade scents '.

Clothes and skin are dusted with *agar* powder as a preventive against fleas and lice. *Agar* has been described as a stimulant, cordial, tonic and carminative, and enters into several compound preparations (Koman, 1918, 25 ; 1919, 45, 47, 48 ; 1920, 23). In Malaya, it is also used as a cosmetic and liniment in various skin diseases (*Gdns' Bull.*, 1930, **6**, 375). It is now mainly used in the making of fumigators and pastilles. It is an important ingredient of various sweet-smelling substances from which *agar-batties* are made. The aromatic wood is comparatively durable and is occasionally used by cabinet makers and inlayers.

Plentiful extraction of the perfumed wood was done in various parts of Assam about the year 1900. Since then the quantity of *agar* extracted seems to have gradually declined, amounting to only 670 mds. (491 cwts.) during the five years ending in 1922 from Cachar Division (Pearson and Brown, *loc. cit.*, 860). Assam *agar* used to go to Calcutta and from there to Turkey, Arabia, Persia and Europe. At present Indian *agar* is largely exported to China where it is used as incense and in the manufacture of joss-sticks. Burma had a large trade in *agar* with China (Hooper, *loc. cit.*).

The bark of *A. agallocha* is thin, fibrous and even in surface and texture. A home-made paper prepared from the bark (see Hooper, *loc. cit.*, for method of preparation) has been used for ages in Assam, but it is now of little importance. Hooper and Leather (*Annu. Rep. Bd. sci. Adv. India*, 1909-10, 17) found that the crude bark (*sacchi* bark of Assam), and the cleaned bark prepared for writing, contain : cellulose, 41·8, 53·1 ; ash, 10·7, 5·2 ; water, 9·3, 10·2% respectively. Ropes of fair quality can be made from the bark (Rodger, 94).

A. malaccensis Lam. MALACCA EAGLE-WOOD

D. E. P., I, 282 ; Fl. Br. Ind., V, 200.

It is a small evergreen tree found in Tenasserim, Burma, and extending to Malacca and the Malayan Archipelago. From an investigation of the minute structure of the wood, Metcalfe (*Kew Bull.*, 1933, 4-5) reports it to be similar to that of *A. agallocha.*

It is the chief source of the Malayan Aloe-wood and is put to the same uses as *A. agallocha*. It yields an inferior quality of aromatic wood, which is found in the market as ' Singapore agaru ' (Dutt, 36). It is also resinous (40% alcohol solubles) and yields an essential oil (Wehmer, II, 813).

The hill tribes in some parts of Malaya Peninsula prepare a cloth from the fibrous bark and use it for making coverings for the head. It is sometimes used for lining baskets in Borneo (Burkill, I, 203).

ARACHIS Linn. LEGUMINOSAE

A Brazilian genus of low tropical herbs, comprising about 7–10 species. *A. hypogaea* is one of the most important oil-seed crops of the warmer regions of the world.

A. hypogaea Linn.

GROUNDNUT PEANUT, MONKEY NUT

D.E.P., I, 282 C.P 74 Fl. Br. Ind., II, 161.

HIND.—*Mung-phali* ; BENG.—*Chini-badam* ; MAR.—*Bhui mug* ; TEL.—*Verusenagalu* ; TAM.—*Verkadalai* ; KAN.—*Nela-gadale* ; MAL.—*Nelakadala.*

A small branched herb which grows erect (ht. 1–2'), or trails on the ground, and bears small yellow flowers. After fertilisation the base of the ovary develops a long stalk (gynophore) which pushes the ovary into the soil where it begins to develop into a pod maturing in about 2 months. The cylindrical reticulated pods or ' nuts ' (1–2") usually contain two seeds within the outer shell. Each seed is covered by a coloured seed-coat, and consists of two white fleshy cotyledons rich in oil and protein.

Brazil is regarded as the home of the groundnut, but it is now cultivated in all tropical and subtropical countries. The major groundnut producing countries are India, China, the U.S.A. and West Africa. Groundnut is also cultivated in Burma, the East Indies, Nigeria, and in southern Europe.

TABLE I

AVERAGE ANNUAL ACREAGE AND PRODUCTION OF GROUNDNUTS (IN SHELL) IN THE WORLD DURING 1933-37

	Acres (in thousands)	Tons (in thousands)
India . .	7,000	2,822
China . .	3,574	2,672
French West Africa	3,105	793
U. S. A. . .	1,661	540
Others . .	4,011	1,376
Total	19,351	8,203

The plant is reported to have been introduced into India in the 16th century. Its cultivation extended at a phenomenal rate since 1900, and today India is the largest producer of groundnuts accounting for more than 35% of world production.

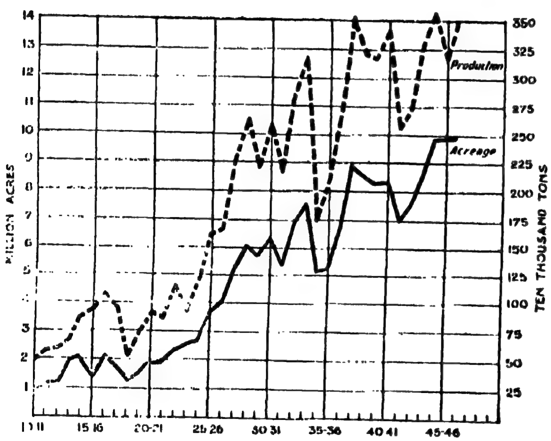
TABLE II

AVERAGE ANNUAL ACREAGE AND PRODUCTION OF GROUNDNUTS (IN SHELL) IN INDIA

	Acres (in thousands)	Tons (in thousands)
'00-01/'09-10	575	256
'10-11/'19-20	1,498	735
'20-21/'29-30	3,613	1,535
'30-31/'39-40	6,898	2,722
'40-41/'44-45*	8,813	3,373

* *Indian Tr. J.*

ACREAGE AND PRODUCTION OF GROUNDNUTS (IN SHELL) IN INDIA



VARIETIES AND CULTIVATION

Groundnut can adapt itself to a variety of soil and climatic conditions and is now found cultivated in different types of soil such as sandy, sandy loam, loamy and black soils, but it thrives best in light sandy loam soils. Soils deficient in lime are reported to produce kernels, which are not fully developed. It cannot stand frost, long or severe drought, or water stagnation. Heavy and continuous rainfall results in excessive vegetative growth, prolonged duration of crop, and low yields of pods. Groundnut comes up well in tracts, receiving 25–50 inches of well distributed rainfall.

There are several varieties and forms under cultivation. These differ in the habit of growth, the duration of the crop, the size and shape of the pods, and kernels, etc. Nearly 50 distinct types from different groundnut producing countries of the world, have been collected and are being maintained by the Department of Agriculture, Madras.

The commonly cultivated varieties are broadly divided into two groups : the 'bunch' or 'erect', and the 'runner' or 'spreading' (Pl. XVI, 1 & 2). The former is generally of short duration and matures in 3–4 months. The branches grow erect and the pods appear in a cluster confined to the base of the plant. The pods are generally small or medium-sized and contain 1–2 small round seeds within a thin shell. The spreading varieties take 4–6 months to ripen and the pods are borne along the length of the branches. They are medium-sized and contain 1–3 oval seeds in a comparatively thicker shell.

The principal varieties under cultivation in India were introduced at the beginning of this century. These are the 'Coromandel' and the 'Bold' belonging to the runner type, and the 'Peanuts' and the 'Red Natal' of the bunch type (Pl. XVI, 3–6). The kernels from the Coromandel variety are of medium length, somewhat smaller than those of the Bold which gives long, large kernels, counting not more than 60 per oz. Peanuts yield small round kernels, having a count of not less than 77 kernels per oz. The kernels from Red Natal have a deep red skin and yield a coloured oil.

Two more varieties, the 'Karad' and the 'Virginia' are found to a limited extent in Bombay Province. The former is grown in Satara dist. and the latter in Surat dist. In size and appearance, the pods and kernels of the Karad variety are intermediate between those of the Bold and the Coromandel. Virginia and Bold are similar.

Breeding and selection work carried out in Madras and Mysore have resulted in the evolution of certain high yielding types like A. H. 25, A. H. 685,

A. H. 698, A. H. 186, A.H. 113 and H.G. 1. These when tested in different parts of Madras, Bombay, Hyderabad and Mysore were found to yield more nuts (20%) than local varieties. They also showed higher shelling percentage (73% against 71%) and higher oil content (51·2% against 50·3%). These varieties are considered to be suitable for many parts of India (Burns, 75).

The important characters for judging the quality of groundnuts are : (1) the oil content of the kernel, (2) the shelling percentage, *i.e.*, the proportion of kernels to pods, and (3) the colour and size of pods and kernels. Of the various varieties cultivated, Khandesh is the best for oil extraction, since it has not only the highest oil content, but also yields an oil of lighter colour than other varieties. However, in Madras, Coromandel is preferred both by millers and exporters, as Peanuts give oil with more sediment. Peanuts grown in Madras and Hyderabad show a much lower oil content than those grown in the C.P., and Bombay.

The maximum percentage of oil is obtained only from well developed kernels. Harvesting the crop even a week in advance of proper maturity adversely affects the oil content. The oil content is somewhat higher when the crop suffers from want of water than when it has excess of rain. The percentage of free fatty acids is also an important factor in judging the quality of the produce, especially when the oil extracted is intended for the manufacture of margarine, vegetable ghee, etc. Oil from ripe and sound kernels contains only 0·1–0·2% of free fatty acids. Higher free fatty acid content renders kernels unfit for use as edible oil.

The shelling percentage is found to vary in different varieties, and in the same variety in different years, depending upon seasonal conditions. Bunch varieties generally possess a higher shelling percentage (80%) than spreading varieties (60–75%) which have thicker shells. When groundnut pods are sold by volume, the weight per unit volume of pods is sometimes utilised in assessing shelling percentage.

When the produce is sold for edible purposes, the size of pods and kernels and their colour are of importance. Light golden yellow pods, and rose-coloured kernels are generally preferred. Bold and Virginia nuts are in greater demand for edible purposes, since they have larger nuts with lower oil content and higher protein content. Artificial bleaching of pods is carried out in some foreign countries.

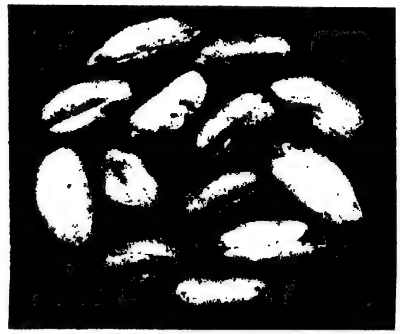
TABLE III

CHARACTERISTICS OF COMMERCIAL VARIETIES OF GROUNDNUT

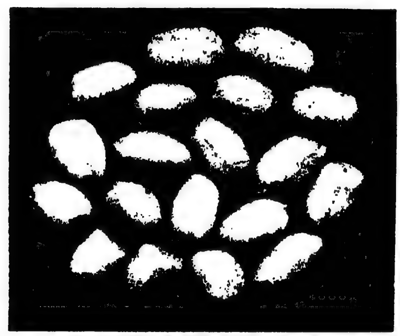
	Variety	Shelling percentage	Bushel wt. of kernels (lb.)	Per cent. of oil	Major areas	Per cent. of production	Average annual production in '33-34–'37-38 (1,000 tons)	Per cent. of total production
1	Coromandel, Mozambique or Mauritius.	69	51·3	48·28	Madras	85	1,574	56
2	Bombay Bold, Big Japan . .	68	50·1	46·91	Bombay States Bombay Hyderabad	39 25 26	506	18
3	Peanut, Spanish peanut, Khandesh, or Natal.	72	53·1	48·40	Bombay Madras Hyderabad	32 25 30	618	
4	Red Natal, Red Ponani, *Lal Boria*, *Lal Dana*, or Pollachi Red, Small Japan.	74	54·1	47·51	Madras C.P. & Berar	50 31	62	
5	Others						62	
							2,822	

1. GROUNDNUT (ARACHIS HYPOGAEA)—RUNNER TYPE

3. COROMANDEL

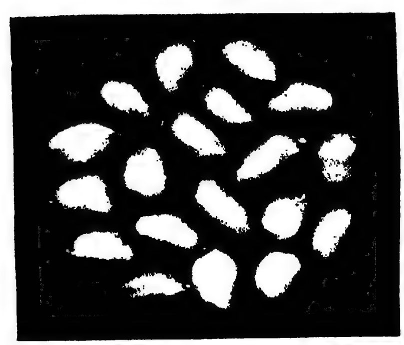


4. BOLD



5. PEANUTS

2. GROUNDNUT—BUNCH TYPE



6. RED NATAL

TABLE IV

CHIEF CENTRES OF PRODUCTION AND DISTRIBUTION OF VARIETIES ('33-34—'37-38)

Province or State	Districts	Variety	Acreage (per cent.)	Production (per cent.)
Madras	Central districts of Chittoor, North and South Arcot, Salem, Trichinopoly and Coimbatore (36%), Ceded districts of Cuddapah, Kurnool, Bellary and Anantpur (34%) and the Circars districts of Vizagapatam, E. & W. Godavari, Kistna and Guntur (28%)	Coromandel	80	88
		Peanut	10	10
		Red Natal	3	2
Bombay	W. & E. Khandesh, Satara, Sholapur, Bijapur, Belgaum (72%)	Peanut	50	42
		Bold	25	27
		Coromandel	20	26
		Red Natal	2	2
Bombay States	Bhavnagar, Junagadh, Nawanagar, and Gondal	Bold	80	85
		Peanut	10	11
C. P. & Berar	Buldana, Akola, Amraoti and Nimar	Red Natal	40	42
		Peanut	33	33
		Bold	10	11
Hyderabad	Gulbarga, Osmanabad, Bhir, Raichur, and Mahboobnagar	Peanut	40	47
		Bold	33	33
		Coromandel	20	20
Mysore	Chitaldrug, Tumkur, and Kolar	Coromandel	50	50
		Peanut	50	40

In India, groundnut is generally grown as a rain-fed or monsoon crop. In some areas, it is also cultivated as an irrigated crop, when it is sown in February–March and harvested in June–July. In Madras, Bombay, the C.P., the U.P., and Hyderabad it is sown mostly in June to August, depending upon the monsoon, and harvested from September to January. In Assam and Pollachi (Madras) it is sown as early as April or May, since they receive the south-west monsoon rains very early, while in Tinnevelly and Ramnad dists. (Madras) where the rainy season is later, sowing is delayed till September or October.

Groundnut is not an exhausting crop and usually no systematic rotation is practised in its cultivation. Often the same area is sown with this crop year after year. No appreciable reduction in yield has been observed. However, in certain parts of Madras, groundnut is alternated with cereals or cotton. In favourable situations, it is followed in the same year, by maize (*Zea mays*), sorghum (*Sorghum* spp.) gingelly (*Sesamum indicum*) or horse-gram (*Dolichos biflorus*). In irrigated areas, it is rotated with paddy, sugarcane, sweet potatoes, etc. Since groundnut is a leguminous plant, it enriches the soil with respect to nitrogen, and higher yields are obtained with crops that follow. In some areas, groundnut is also grown as a mixed crop with cereals like sorghum, bajra (*Pennisetum typhoides*), ragi (*Eleusine coracana*), etc., or oil-seed crops like castor (*Ricinus communis*), gingelly, etc., and with pulses like *arhar* (*Cajanus cajan*), the most common mixtures being groundnut-castor and groundnut-*arhar*. Only bunch types are used in mixed sowing. The groundnut usually matures earlier, and is harvested before the other crop.

The best nuts are selected for seed and are carefully preserved. Seeds of most of the bunch types are non-dormant, i.e., they germinate, if sown about 10–15 days after harvesting. But the seeds of the spreading types are dormant and require a resting period of 2–3 months before they are sown. The pods are shelled by hand just before sowing, taking care to avoid injury to the kernels, and selected seeds are used for sowing. In the case of the bunch types, about 100 lb. of kernels are required for sowing an acre, and in the case of the spreading types, about 75–85 lb. Under irrigated conditions, the seed rate may be reduced by about 20%.

The land is prepared for cultivating groundnuts by ploughing it 2–4 times, immediately after the first showers of the South-West monsoon. In black soil areas, instead of ploughing, the *guntaka* (blade harrow) is worked several times. Dibbling the seed in furrows behind the wooden plough is the common method of sowing in the major groundnut growing areas in India. In the Ceded Districts of Madras, however, 3–6 tyned seed drills with 9½–11″ spacing between coulters is used for sowing and the seed is covered by working a *guntaka*. In Madras, a spacing of about 9–12″ for spreading types, and 6–9″ for bunch types is found to be economic. In Bombay, a spacing of 1′ between rows and 9″ between plants in the row is advocated. When groundnut is raised in rich soils receiving good rainfall, or under irrigated conditions, a wider spacing of about 1–1½′ may be necessary.

Normally two hoeings and weedings are given to the crop, the first about three weeks after sowing, at the time of first flowering, and the second, about a month later. No hoeing or weeding is done after the plants have grown and pod formation has started, as it will disturb the development of the ovaries inside the soil into pods. Intercultivation is generally done with hand hoes, having blades, 1–2″ broad. In localities where bunch varieties are grown, sometimes plants are earthed up by ploughing. This is said to facilitate the penetration of the gynophores and to increase pod production.

Usually, only cattle manure and ash are used for this crop (2–5 tons per acre), the manure being applied just before sowing time. Where the soil is sandy, it is customary to apply tank or channel silt (15–20 tons per acre) once in 3–5 years. Sheep or cattle penning is also in vogue in some of the districts. When groundnut is rotated with other crops, it is customary to manure the crop preceding it and to raise groundnuts without direct manuring.

The response of groundnut to fertilizers has been studied in some of the experimental stations in India. In the black cotton soils of Bombay and the Central Provinces, nitrogenous manures have no effect on yield. A definite respons e to the application of potassium sulphate has been obtained at Akola Experimental Station (C. P.). In Burma, in light sandy loam, alkaline and poor in all the essential elements of plant food, nitrogenous manures alone have been reported to have given enhanced yields. In light sandy loam soil, according to the investigations of the Agricultural Research Station, Tindivanam (Madras), groundnuts respond to an application of potash and phosphoric acid, but not to nitrogen.

When the crop reaches maturity, leaves begin to wither and turn yellow. The development of a distinct tint inside the shell is also an indication of maturity. A few plants are pulled out to see if the majority of pods are free from extra moisture in the shells. Harvesting is the costliest operation in the cultivation of groundnuts. The bunch varieties are generally collected by pulling out the plants. If there is sufficient moisture in the soil, all the pods come out with the plants, but if the soil is dry and hard, the plants are lifted by working a harrow or by using a hand-hoe. The pods after drying are removed by hand, or by beating the plants against a bar. In the case of spreading types, the fields have to be dug up with spades, ploughed, or harrowed, before the vines are gathered, and the pods are hand-picked from the soil. In the Ceded Districts a blade harrow, called *pedda guntaka*, drawn by bullocks, is made use of. In certain tracts, smaller *guntakas* or wooden ploughs with attached blades are used for uprooting the vines.

The pods are stripped from the vines immediately after harvesting, particularly in rainy tracts. In the drier areas the plants are heaped up after drying and the pods are later shaken out. Where groundnuts are grown in gardens or on wet lands, it is usual to allow the fields to dry first and then to irrigate and pull out the vines. The pods are dried soon after harvesting to prevent deterioration. Inadequately dried nuts are liable to develop free fatty acids.

The cultivators sell their produce mostly as nuts in shell. It is decorticated before it reaches the millers and exporters. Decortication helps to reduce volume and freight in the movement of the produce but the kernels get exposed to insect attacks and become liable to rapid deterioration.

Groundnuts are shelled either by hand or by machinery. 'Hand-shelling' as understood in the trade consists in beating the nuts with sticks, followed by separating the kernels by winnowing. It is customary to moisten the nuts, the previous evening, in order that the kernels may not break into pieces. But the moisture absorbed by them increases the free fatty acid content of the oil. Mechanical decorticators have also been developed for shelling. The decorticators used in India are of two kinds, viz., the 'Beater' type and the 'Grate' type, and both types of machinery are made in India. In the Beater type, the nuts are shelled by steel plates revolving at a high speed in a perforated drum, and in the Grate type they are rolled against a grate by revolving crushing plates. The moisture content of the nuts, and the speed of the decorticators are regulated to minimise the percentage of 'splits' and 'brokens'.

The yield of groundnuts varies considerably in India. Spreading types give a much higher yield than bunch types. The yields under irrigated conditions are nearly double those obtained when groundnut is grown as a dry crop.

TABLE V

AVERAGE ANNUAL YIELD PER ACRE IN THE IMPORTANT GROUNDNUT TRACTS OF INDIA DURING '38/39 - '42/43*

	lb. per acre
Madras	990
Bombay (including Bombay States)	799
Central Provinces	641
Hyderabad	757
Mysore	529

* *Indian Tr. J.*

The yield per acre is higher in Madras, and the average yield in India compares favourably with those recorded in Africa and the U.S.A., but it is less than those obtained in China (1,630 lb.) and in Mauritius (2,230 lb.). Very high yields have been reported from some of the Government Research Stations in India (1,744 lb. per acre for the rain-fed crop, and 3,328 lb. for the irrigated crop).

The groundnut crop is subject to three important insect pests: the Red Hairy caterpillar (*Amsacta albistriga* Walk.), the *Surul* moth, a small leaf miner caterpillar (*Stomopteryx nerteria* Meyr.), and a stem burrowing beetle, the *Verpoochi* (*Sphenoptera perotetti* G).

Amsacta albistriga does considerable harm to the crop in Madras, Hyderabad and Mysore. After the heavy rains of the South-West monsoon the moths emerge from the pupae in the soil and lay their eggs in large numbers on the leaves of the plants. The Red Hairy caterpillars that hatch out feed voraciously on the leaves, and sometimes entire fields are laid bare. When badly infested fields of the previous season are ploughed by means of an inversion plough, the pupae are exposed. They may then be collected and destroyed. The moths which appear soon after the rains (in July and August) are very sluggish and may be hand-picked and killed. It is also advisable to dig trenches round fields infested by this pest, to trap the caterpillars and to prevent their migration.

Stomopteryx nerteria occurs in areas of deficient or badly distributed rainfall. The pest is the larvae of a small moth which webs several leaves together and feeds on them. The life cycle of the moth is very short and sometimes four broods have been noticed in one season. Dry weather favours the pest. Owing to its habit of burrowing into the leaf tissues, spraying is not of much use as a remedy. The moths are attracted by strong light at night, and the use of light traps is suggested.

The larvae of the beetle *Sphenoptera perotetti*, burrow into the stem of the plant, close to the soil surface, or into the main root. The attack is generally found in irrigated fields. The only preventive measure consists in destroying the plants attacked by this pest and killing the beetles where possible. Bugs, *Aphanus sordidus* Fabr., have been reported to cause considerable damage to groundnuts in Bombay. They appear in large numbers and draw out the oil from the kernels, both in the fields and on the drying floor. Occasionally they are also found to infest stored material.

The 'tikka' disease is due to a fungus (*Cercospora* sp.) which attacks leaves, causing small yellowish spots which gradually spread out, and the leaves drop out later. Spraying with fungicides like Bordeaux mixture, colloidal copper, etc., or dusting with sulphur has been found beneficial. The wilt disease (*Rhizoctonia bataticola*) occurs in a spasmodic form in summer months. The leaves and branches gradually dry out. Another disease which is regarded as due to a virus, causes a dwarfing of the plant and a crowding or shortening of the leaves leading to a rosette-like appearance. This disease is very destructive in South Africa but has not yet become serious in India.

When the crop is maturing, wild pigs and crows cause considerable damage in some localities. Several caterpillars, beetles and ants attack nuts stored in the form of kernels. Nuts in shell are less liable to deterioration.

GROUDNUT PRODUCTION & USES

Groundnut is the most important oil-seed crop of India. The total acreage under this crop in '44-45 was estimated at nearly 1,06,00,000 acres, and the production of nuts in shell, at 39,00,000 tons. The cultivation of groundnut is mostly confined to southern India, and Madras has the largest acreage, and is followed by Bombay and Hyderabad.

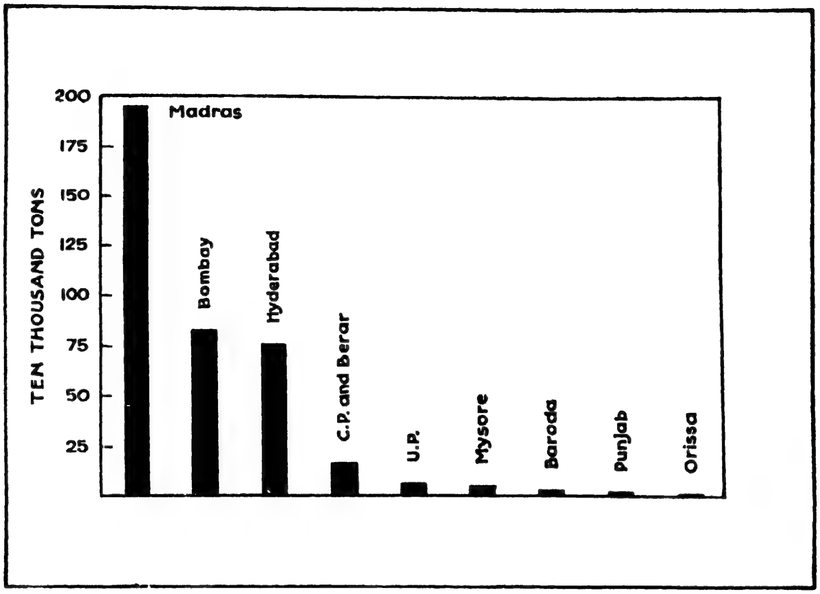
TABLE VI

DISTRIBUTION OF ACREAGE AND PRODUCTION OF GROUNDNUTS (IN SHELL)

Province or State	Acreage (1,000 acres)		Per cent. of total acreage		Production of nuts in shell (1,000 tons)		Per cent. of total production	
	Average '33-34/'37-38	In '44-45*	Average '33-34/'37-38	In '44-45	Average '33-34/'37-38	In '44-45*	Average '33-34/'37-38	In '44-45
Madras	3,361	4,300	48·0	40·7	1,523	1,951	53·9	50·6
Bombay and Bombay States	1,804	2,540	23·6	24·0	706	828	25·0	21·5
C. P. & Berar	170	606	2·4	5·7	46	164	1·7	4·2
U. P.	85	130	1·2	1·2	47	62	1·6	1·6
Punjab	..	64	..	0·6	..	14	..	0·4
Orissa	..	18	..	0·2	..	7	..	0·2
Hyderabad	1,181	2,604	16·9	24·6	394	761	14·0	19·7
Mysore	200	210	2·9	2·0	41	47	1·4	1·2
Baroda	..	102	..	1·0	..	22	..	0·6
Others	199		5·0		65		2·4	
Total	7,000	10,574			2,822	3,856		

**Indian Tr. J.*, *vide* map facing last page.

PRODUCTION OF GROUNDNUTS (IN SHELL) IN DIFFERENT PROVINCES IN INDIA IN '44-45



During '33-34/'37-38, 61% of the total production was retained in India and the rest exported. Internal consumption was: for seed, 11·4; for edible purposes 6·7; and for oil extraction, 42·5%.

TABLE VII

AVERAGE ANNUAL CONSUMPTION OF GROUNDNUTS (IN SHELL) IN INDIA DURING '33-34/'37-38

(In thousand tons)

	Seed	Edible purposes	Oil extraction	Total
Madras	172	70	475	717
Bombay	48	30	350	428
Central Provinces	6	5	32	43
United Provinces	3	14	30	47
Other Provinces	1	27	13	41
Hyderabad	45	15	125	185
Mysore	7	5	20	32
Bombay States	33	6	125	164
Other „	7	16	30	53
Consumption in India	322	188	1,200	1,710

In a note on the progress of the 'Grow More Food Campaign' (Govt. India, Dep. Educ. Hlth. & Lands, 1945), the production of groundnut kernels in '43-44 has been estimated at 2,001,000 tons (or 2,859,000 of nut in shell). Of this 267,000 tons (13·3%) were exported leaving a balance of 1,734,000 tons for internal consumption. The quantity used for seed, food, etc., was estimated at 450,000 tons (22·5%). The rest, 1,284,000 tons (63·9%) was used for the production of groundnut oil.

Groundnuts are a cheap and rich source of fat, protein and vitamins B_1 and B_2, nicotinic acid, and vitamin E (26 I. U./100 g., Pickett, *Chem. Abstr.*, 1942, **36**, 4213). Sarma (*Indian J. med. Res.*, 1944, **32**, 117) has reported the occurrence of 7·26 µg. per g. of vitamin B_6 (pyridoxine). The red skins are particularly rich in vitamin B_1. During processing nearly 90% of this vitamin is lost. The nuts are comparatively poor in vitamin A, and contain hardly any vitamin C. Groundnuts are also a good source of lecithin which is present to the extent of 0·5–0·7% of the decorticated nuts (Traill, *Chem. & Industr.*, **1945**, 58; Jacobs, II, 574).

TABLE VIII

COMPOSITION OF GROUNDNUTS AND GROUNDNUT PRODUCTS

(Per 100 G.)

		Per cent.										Vitamins/100 g.			
		Moisture	Protein	Fat	Carbohydrates	Fibre	Ash	Cal. val.	Calcium	Phosphorus	Iron(mg. 100g.)	A (I.U.)	B_1 μg.	B_2 μg.	Nicotinic acid (mg.)
Raw nuts (Indian)	(a)	7·9	26·7	40·1	20·3	3·1	1·9	549	0·05	0·39	1·6	63	300 I.U.	..	14·1(d)
Roasted nuts (Indian)	(a)	4·0	31·5	39·8	19·3	3·1	2·3	561	0·05	0·44	0·3	..	..	..	..
Peanuts	(b)	2·6	26·9	44·2	21·2	2·4	2·7	590	0·07	0·40	2·0	360	680	500	13·0
Peanut butter	(b)	1·7	26·1	47·8	19·0	2·0		611	0·07	0·40	1·8	360	300	500	17·0
Peanut flour	(c)	4·4	59·0	9·	20·6		3·8		0·07	0·	0·01'		(e)600	300	20·0

(a) *Hlth. Bull.*, No. 23, 1941, 35 ; (b) Heinz Co., Nutrit. Charts, 1942, 25 ;
(c) Jacobs, I, 682 ; (d) Swaminathan, *Indian J. med. Res.*, 1944, **30**, 39 ;
(e) Zucker and Zucker, *Industr. Engng. Chem.*, 1943, **35**, 868.

Groundnuts may be eaten either raw, or after roasting, but in general, roasted ones are preferred. They are used in numerous ways, salted, sugared, or mixed with sweetmeats and other edible preparations. Groundnuts prove rather indigestible owing to their high oil content, and also because in chewing, the kernels are not broken into sufficiently small particles.

In America, groundnuts are known as peanuts and have become extremely popular. It is estimated that in 1942 approximately 600,000 tons were shelled for out-of-hand eating, confectionery and peanut butter (Payne, *Chem. & Engng. News*, 1942, **20**, 1173). Peanut butter has become a common article of diet. It is prepared by grinding roasted blanched kernels after removing seed-coats and seed-germs. It is generally made from a mixture of Spanish and Virginia peanuts (40 : 60). The butter made from Spanish peanuts (oil content, 47–50%) is too oily, and that made solely from Virginia peanuts (oil content, 38–47%) is too dry. Selected kernels are mixed with salt (1–4%) ground or crushed into a fine paste or 'butter', and packed in hermetically sealed tins. Peanut butter has nearly the same composition as peanuts roasted in shell. Large quantities are used for the manufacture of sandwiches, candy and bakery products.

Peanut flour is a recent development in the U.S.A. (Payne, *loc. cit.*). It is prepared by grinding the finest grades of peanut cake. Sizing is carried out by means of air separators, since in bolting, the flour blinds the cloth used.

According to Zucker and Zucker (*Industr. Engng. Chem.*, 1943, **35**, 868), peanut flour, like cotton-seed and soya bean flours, is specially suitable for supplementing white flour. In making bread, it can replace white flour up to 12 50%, and 30% replacement is the maximum limit. Peanut flour has great possibilities as a cheap protein food.

Owing to the high fat and protein content, groundnuts form a valuable energy giving food. Nearly 96% of the nutrients are digestible. The calorific value of groundnut (549 cals./100 g.) is nearly 5 times that of beef (114 cals./100 g. ; *Hlth. Bull.*, No. 23, 1941, 35). The nutrient ratio is approximately 4, and 100 g. are equivalent to 131·4 g. of starch (*vide* Table XI).

The value of groundnut protein as human food is now well established. Mitchell and Beadles (*J. Nutrit.*, 1937, **14**, 597) in experiments on rats found that the true digestibility of the protein of raw nuts was 97·4%, and biological value, 57·9. From the nutritional point of view, good quality groundnut cake is a concentrated food almost equivalent to meat, and in general quality, it compares favourably with proteins from soya beans and cotton seeds. Further, while soya bean proteins are efficient only after they have been heated, raw groundnut protein is of high nutritional value nearly equal to those of meat and eggs.

The principal constituents of groundnut protein are the two globulins, arachin and conarachin. Jones and Horn (*J. agric. Res.*, 1930, **40**, 673), found that the oil-free meal prepared from Virginia peanuts contains N, 7·36% which is equivalent to 40–48% (N×5·5) of crude protein. Arachin is present to the extent of approximately 25% and conarachin, 8% of the oil-free meal (cf. Kotasthane and Narayana, *Proc. Indian Acad. Sci.*, 1937, **6B**, 376).

The amino acid distribution of arachin and conarachin has been tabulated by Traill (*loc. cit.*; cf. Jacobs, I, 691). Conarachin has a higher content of cystine, tryptophane, and lysine. Recently Kotasthane and Narayana (*loc. cit.*) have carried out the analysis of protein from groundnuts grown in India, and compared the total globulins of groundnut with the total proteins of milk, of soya beans and of gram (*vide* Table IX). In general, groundnut proteins compare more favourably with milk proteins than soya bean proteins, and are in some respects superior to the latter.

TABLE IX

AMINO ACIDS IN DIFFERENT PROTEINS (PER CENT.)

Amino acid	Total globulins in groundnut cake	Arachin	Conarachin	Milk	Soya bean	Gram
Arginine	13·3	13·6	13·1	4·8	5·1	11·9
Histidine	1·6	2·0	1·9	2·6	1·4	1·4
Lysine	4·7	4·4	5·0	6·0	2·7	7·4
Cystine	1·4	1·2	1·6	1·2	0·7*	2·0
Tyrosine	4·8	5·4	3·2	4·5	1·9	3·0
Tryptophane	0·7	0·7	1·1	1·5	1·9*	0·5

Markley & Goss, 17.

GROUNDNUT OIL

The major portion of the crop produced in India is pressed to yield groundnut oil. Various types of machinery are used, but the important ones are the bullock-driven *chekku* or *ghani*, the power-driven rotary mill and expellers. The *ghani* is employed in villages for pressing out the oil. It is really a pestle and mortar. The mortar is generally made of wood, or rarely of granite, and is fixed to the ground. The pestle which is made of wood is connected to a shaft and is operated by bullocks. The *ghani* oil is not filtered. Sometimes a small quantity of water is added to the oil to help clarification.

The *ghanis* usually crush groundnuts in the form of kernels, but nuts in shell, and nuts in shell mixed with kernels are also crushed. The yield varies from 35–39% by weight of kernels. Since the seeds are pressed cold, the oil is free from mucilage and albuminous matters. It is said to be of superior quality, and is preferred for edible purposes. More than one third of the total weight of oil produced in India is from *ghanis*. Although the *ghani* is not a very effective means of producing the oil, it has the advantage of providing work to the cultivator and of dispensing with a considerable amount of cost of transport and distribution of seed, oil and cake. Besides, cold pressing does not lead to loss of vitamins.

The power-driven rotary mill is an adaptation of the *ghani*. Both the pestle and the mortar are made of iron and are moved in opposite directions. The yield of oil ranges from 36–42%. Expellers are employed in most of the larger factories. The meal is heated prior to pressing by passing it through a steam-jacket or a steam-heated kettle. The yield of oil is about 40–44% and the oil produced is somewhat yellow in colour. Expellers are increasingly used for crushing groundnuts, not only in the producing areas, but also in important consuming centres.

Among the other types of machinery mention may be made of certain presses such as the screw press and the wedge press. Hydraulic presses of the open or cage type have not found much favour, and in India there are no plants for the extraction of oil by solvents.

Enquiries made during the Marketing Survey (1940) showed that there are nearly 650 expellers, 2,100 rotary mills and 29,000 *ghanis* and 300 hand

presses operating on groundnut exclusively, or more commonly, with other oil-seeds. The bulk of groundnut crushing is carried out in Madras and Bombay which together account for nearly 70% of the oil produced in India.

The production of groundnut oil in India has increased very considerably in recent years. The average annual production of oil and cake during '33-34/'37-38 was 336,000 tons and 504,000 tons respectively. It is estimated that the corresponding figures for '43-44 are 514,000 and 770,000 tons (Govt. India, Dep. Educ. Hlth. & Lands, cited on p. 97).

According to the Food Department, Government of India, the following are the estimates of the production of oil in different areas in '46-47 (in 1,000 tons):

TABLE X

GROUNDNUT OIL PRODUCTION IN INDIA ('46-47)

Madras	287·1
C. P. & Berar	32·0
Bihar	6·0
Orissa	5·0
U. P.	4·0
Mysore	16·0
Baroda	17·0
Gujarat States	1·0
W. I. States	96·0
Deccan States	16·0
C. I. States	6·0

Large quantities of groundnut imported from Africa and Asia, are crushed in England, France, Holland and Germany. For obtaining high grade pale-yellow oil, the kernels after the removal of seed-coats, are cold-pressed in hydraulic presses. The cake is then ground, mixed with a little water, heated and again pressed. The oil thus obtained is also suitable for edible purposes. The cake is again ground and pressed hot. The oil obtained by this third pressing can be rendered edible by refining. Solvent extraction is also practised in Europe.

In the U.S.A., clean kernels are crushed, heated in a cooker, and pressed hot in hydraulic presses. Only one pressing is made, leaving the cake with 6–8% of oil. After expression, the oil is filtered and allowed to stand in tanks until the 'foots' (meal) settle. Crude groundnut oil, separated from foots immediately after expression, has excellent keeping qualities. Oil obtained from good kernels is suitable for edible purposes, and crude oils are refined.

Cold pressed groundnut oil is golden yellow in colour and has a faint agreeable odour and a bland taste. The hot pressed oil has a strong reddish yellow tinge and is sometimes even brown. It is a non-drying oil and has the following constants: sp. gr., 15°/15°, 0·916–0·921; $n_D^{15°}$, 1·47; sap. val., 189–196; iod. absorption, 85–98%; acid val., 2–6; unsap., 0·3–1·0% (Hilditch, 119). The component acids are: palmitic, 8·3; stearic, 3·1; arachidic, 2·4; behenic, 3·1; lignoceric, 1·1; oleic, 56·0; and linoleic, 26·0% (by weight). The presence of small proportions of behenic, arachidic and lignoceric acids is characteristic of this oil. The separation of these acids is employed as a test for the detection an the approximate determination of groundnut oil (Jamieson, 157).

The glycerides of the oil are of the evenly distributed class, with negligible fully saturated components, and practically all the saturated acids are in the form of monosaturated dioleins (probably both monosaturated dioleins and monosaturated oleolinoleins); tri-unsaturated glycerides form about 45% of the oil and probably include about 25% of linoleo-diolein and about 20% of triolein (Hilditch, *loc. cit.*, 164).

Groundnut oil is predominantly an edible fat. In India, the oil prepared in *ghanis* is preferred for culinary purposes. Large quantities of the oil are also employed for adulterating costlier edible oils, such as the gingelly, rape and mustard oils. The oil expressed from kernels contains some mucilage and albuminous matter. For edible purposes it is generally refined by caustic soda, bleached and de-odorised.

Large quantities of groundnut oil are now used in India for the manufacture of *vanaspati* or vegetable ghee by hydrogenation. The consumption of groundnut oil in this industry has risen from about 44,000 tons in 1938 to over 163,000 tons in 1945. The corresponding figures for *vanaspati* output were 59,000 and 127,000 tons. The proposed expansion of the vegetable ghee industry to produce another 105,000 tons will require 120,000 tons more of vegetable oil, mainly groundnut oil.

In Europe and America, cold drawn oil and refined oil are used as edible fats, and for the

manufacture of margarine. Groundnut oil is a very good salad oil and is often blended with some olive oil. It is not necessary to 'winter' or demarginate it as it does not readily deposit stearin at cold temperatures. The oil is also used for cooking sardines before packing them in olive oil.

Oil of pharmaceutical quality is obtained from the seeds by cold expression. It is pale yellow in colour and has a faint nutty odour (acid val., ≤ 4). Its properties are similar to those of olive oil. The B.P. recommends its use as a substitute for olive oil in areas where the latter is not readily available in making ointments, liniments, plasters and soaps. Addenda 2 & 3 authorise its use in place of olive oil, in a number of official preparations such as solutions of vitamins A and D (*Oleum vitaminatum*). The oil can be sterilised by heating to 150° for one hour and may be used for the preparation of medicines for injection.

In the form of emulsion, it is used for feeding children. In the East, it is considered to be an aperient and an emollient. In veterinary medicine it is used as a nutritive laxative and emollient. It has been employed in the form of an emulsion for the control of several insect pests of plants, and increases markedly the toxicity of insecticides like derris, nicotine, etc.

Groundnut oil (I.N.S. factor*, 102 ; hardness No. 196·3 ; grain solidifying point, 45°) blended with other oils and fats is used in the manufacture of soap. Usually only the lower grades of oil, and soap stocks obtained during refining are used in soap making. It is used to a limited extent in the manufacture of cosmetics, leather dressings, tallow substitutes, etc. Groundnut oil has been employed as a substitute for diesel oil in internal combustion engines with only minor modifications of the engine (Agarwal, Chowdhury, Mukerjee, and Verman, *Bull. Indian Industr. Res.*, No. 19, 1943 ; *vide* also Manzella, *Chem. Abstr.*, 1936, **30**, 2347 ; 1942, **36**, 5331). At normal loads the consumption of the oil was higher than that of mineral oil, but at reduced loads it was lower, in spite of its lower calorific value. Compared with diesel oil, groundnut oil has a somewhat better thermal efficiency, but gives slightly greater (not excessive), deposit of carbon.

* Sap. val. - iod. val.

The oil finds some use as a lubricant, and blends with mineral oil have been developed suitable for use in internal combustion engines, and for lubricating general machinery. It is employed to a limited extent as an illuminant. A 50% blend with kerosene oil has been found to give satisfactory results in ordinary kerosene lamps. Groundnut oil is also used to replace olive oil for oiling scoured wool fibres.

Groundnut cake is one of the cheapest oil-cakes and has a high nutritive value. If the cake is prepared from selected kernels under hygienic conditions, it is suitable for human consumption. Peanut flour referred to already is one of the edible products prepared from it. The following table gives the composition of groundnuts and groundnut cakes :

TABLE XI

COMPOSITION AND NUTRITIVE VALUE OF GROUNDNUTS AND GROUNDNUT CAKES

	Av. Composition (Per cent.)						*Digestive Nutrients* (Per cent.)					Nutrient-ratio	Percentage availability of feeding stuff	Starch equivalent per 100 lb.
	Moisture	Protein	Fat	Carbo-hydrates	Fibre	Ash	Crude Protein	Pure Protein	Fat	Carbo-hydrates	Fibre			
1. Peanuts (*a*)	6·0	26·8	14·9	17·5	2·6	2·2	24·1	22·2	40·3	14·7	0·2	1	99	131·1
2. Groundnut cake (decorticated) (*a*)	10·3	46·8	7·5	23·2	6·4	5·8	42·0	40·6	6·8	19·7	0·5	1	98	73·0
3. Groundnut cake (undecorticated) (*a*)	10·3	30·2	9·1	21·8	22·9	5·7	27·7	26·8	8·2	18·4	2·6	1	86	56·8
4. Groundnut meal (undecorticated and extracted) (*a*)	7·6	31·8	1·9	29·1	25·3	4·3	29·2	28·3	1·5	20·0	2·9	1	84	44·4
5. Groundnut cake (Bangalore) (*b*)	Dry basis	51·8	8·2	26·9	7·4	5·7	..	..	..	..	..	..	..	..

(*a*) Woodman, *Bull. Minist. Agric., Lond.*, No. 124, 1945 ; (*b*) Sen, *Imp. Coun. Agric. Res., Misc. Bull.*, No. 25, 1916, 20.

TABLE XII

MANURIAL VALUE OF GROUNDNUT CAKES
(Per cent.)

		N	P_2O_5	K_2O	CaO
1. Groundnut cake (decorticated)	(*a*)	7·5	1·30	1·50	0·20
2. Groundnut cake (undecorticated)	(*a*)	4·8	81·00	1·10	0·20
3. Groundnut cake (Bangalore)	(*b*)	51·8*	1·28	1·43	0·28

(*a*) Woodman, *loc. cit* ; (*b*) Sen, *loc. cit.*
* Crude protein, dry basis.

In India, two varieties of groundnut cake are marketed : *ghani* cake (62–65% of kernels) obtained when the oil is pressed out by indigenous wooden presses and the 'expeller' quality cake (50–60% of kernels), from power-driven oil mills. The former has a higher oil content (average, 11·2%) than the latter, and is usually preferred for cattle feed.

Groundnut cake constitutes a very valuable concentrated feeding stuff for cattle and other farm animals. It contains a higher proportion of protein and oil than any other oil-cake. Both these are easily digested. The cake obtained, when solvents are used for the extraction of oil, is richer in protein, but is very poor in fat. In European countries, it is used for producing compound cattle foods by mixing it with molasses, starchy materials, etc. Powdered groundnut cake is largely used in the U.S.A. as a hog feed. Unlike kernels, it does not produce soft pork. The addition of groundnut meal to poultry feed stimulates egg-laying and assists in bringing chicken rapidly to marketable size.

Groundnut cake is a good organic nitrogenous manure. It is a particularly valuable manure for paddy, sugar-cane, coffee and tea. In combination with superphosphate and potash, it has been found very beneficial in areca nut cultivation.

An acre of groundnut, when raised as a dry crop, yields about a ton of green haulms, and about a ton and a half when cultivated as an irrigated crop. The haulms and leaves constitute good fodder, when green or after conversion into silage. After harvesting, they are also dried and used as hay. In some parts of south India the haulms, when available, are used as green manure for paddy at the rate of 3,000–5,000 lb. per acre.

The husks constitute 20–32% by weight of the pods, and in India the average is about 30%. Hence large quantities are obtained as a by-product during the separation of kernels. These husks are principally composed of crude fibre (up to 60%) and small quantities of lignin and pentosans. They are of little value for making paper and are only suitable for low grade cardboard (*Bull. imp. Inst. Lond.*, 1925, **23**, 329). Recently Lynch and Goss (*Industr. Engng. Chem.*, 1930, **22**, 903) have been able to obtain 40–42% of unbleached pulp, which could be purified to a product containing 90% of α-cellulose.

The husks have very little food value. They are sometimes used for mixing with groundnut meal, molasses, and other cattle foods, for increasing their volume.

Attempts have been made to use the husks as a substitute for powdered cork for insulating purposes, but their efficiency is 30% less. They are mostly used as fuel, and the ash obtained from them, as manure. Rama Rao (*J. Indian chem. Soc., Industr. & News Edn.*, 1938, 1, 137) has subjected them to destructive distillation and obtained a charcoal (740 lb. from 1 ton of shells) with good decolourising properties.

The red skins (seed-coats), separated from kernels used for the preparation of peanut butter, are almost equivalent to wheat bran in their nutritive value. They are sometimes mixed with varying proportions of ground husks, and the product is known as groundnut bran.

In the preparation of peanut butter, germs are removed before crushing the kernels since they have a bad effect on the quality of the butter. These germs have nearly the same composition as peanuts, and are mostly used in cattle foods, and for feeding poultry.

GROUNDNUT PROTEIN

In recent years groundnut protein has been assuming technical importance. It can be readily prepared from high grade groundnut cake of low oil content (1·0–1·5%), which has not been subjected to a temperature exceeding 40° during extraction of the oil. Such a cake crumbles easily into a white powder, and when treated with 0·1–0·2% of caustic soda, its protein goes into solution. The solution of sodium proteinate

formed is filtered, and the protein is precipitated by the addition of acid or sulphur dioxide. It is allowed to settle, washed free from salts and dried.

TABLE XIII

COMPOSITION OF SOME BY-PRODUCTS

(Per cent.)

	Moisture	Protein	Fat	Fibre	Carbohydrates	Ash
Groundnut shells (*a*)	..	8·2	3·0	59·7	14·8	14·3
Groundnut skins (*b*)	6·5	15·9	22·4	10·6	41·9	2·7
Groundnut hay (*c*)	7·8	11·8	1·8 (on dry basis)	22·1	47·0	17·0
Groundnut germs (*c*)	5·6	30·8	48·4 (on dry basis)	4·8	12·7	3·3

(*a*) Sen, *loc. cit.*, 20 ; (*b*) Woodman, *loc. cit.*, 17 ; (*c*) *Bull. imp. Inst., Lond.*, 1925, **23**, 330.

According to Slade, Branscombe and McGowan (*Chem. & Industr.*, 1945, *loc. cit.*) 22 lb. of pure protein can be obtained from 100 lb. of groundnuts, and the efficiency of the process is over 80%. The quality of the product is so high that it may be used for human nutrition. The residual meal has a nitrogen content about 3%, and probably contains glutelins. It may be used as cattle feed.

Traill (*loc. cit.*) has described the development of a new textile fibre 'ardil' from groundnut protein. In the manufacture of ardil a solution of protein (20-30%) in dilute alkali is extruded at a constant rate into a coagulating bath containing about 15% of sodium sulphate and 1% of sulphuric acid kept at 25-40°. The fibres are spun in the same manner as viscose rayon and subsequently hardened by treatment with a solution of sodium chloride or ammonium chloride, containing a small concentration of HCl (not more than 2 %) and a little formaldehyde.

Ardil is a cream-coloured, crimp fibre with a soft wool-like handle. It resembles wool in many of its properties and is besides moth-proof. But it has poor resistance to abrasion. Ardil fabrics and ardil-wool fabrics give the same thermal insulation as all-wool materials of the same thickness and structure. Ardil can be dyed normally like other protein fibres. It also possesses good affinity for direct cotton dye-stuffs.

Narayanamurthy (*Indian For. Leafl.*, Nos. 15 and 67, 1944) has used groundnut protein for the preparation of glues for the manufacture of plywood. Dry and wet strength glues are obtained by mixing the protein, with lime, lime and caustic soda, or lime and sodium silicate. Where a high degree of water resistance is required, the glue is prepared by mixing the protein with borax, ammonia and a little formalin.

TRADE

Groundnuts: The exports of groundnut have been increasing steadily since the beginning of this century. There was a slight decline during the first world war, but later they continued to increase sharply and reached an annual average of 524,000 tons in the third decade. The rising trend was interrupted during '30-36 as a consequence of world depression.

Exports from British India in '45-46, were 197,000 tons, and in '46-47, 117,000 tons (under control).

The major portion of exports from British India are shipped from Madras while the share of Bombay is much smaller. The Kathiawar State ports, mainly Veerawal (Junagadh), Nawanagar, Bhavnagar and Porbandar, taken together are as important as Bombay. The distribution of exports from Kathiawar ports in '38-39 was : U.K., 65·3 ; Egypt, 16·0 ; France, 3·6 ; Netherlands, 3·1 ; and others, 12·0%.

In addition to exports from British India and Kathiawar ports, there is considerable export also from French (Pondicherry) and Portuguese

ports (Marmagoa). During the quinquennium ending March '38, exports from French ports amounted to 59,000 tons, and from Portuguese ports to 96,000 tons. The average annual export from these ports during the next two years ('38-39/'39-40) was 63,000 and 88,000 tons, respectively. In subsequent years considerable activity was reported from Portuguese ports, but no figures are available.

The Continental countries used to take 75% of India's exports, and the Second World War severely affected this trade. France and Netherlands have been the biggest importers of Indian groundnut. French imports came down from 174,000 tons per year in '23-24/'27-28 to 135,000 tons in the next quinquennium. This fall was due to increased production of groundnuts in French colonies and the imposition of an import duty on groundnut produced outside French territory. France now obtains most of her requirements from Senegal. Restriction on imports to Germany was responsible for the decline of Indian exports from 148,000 tons per annum in '28-29/'32-33 to 90,000 in the next quinquennium.

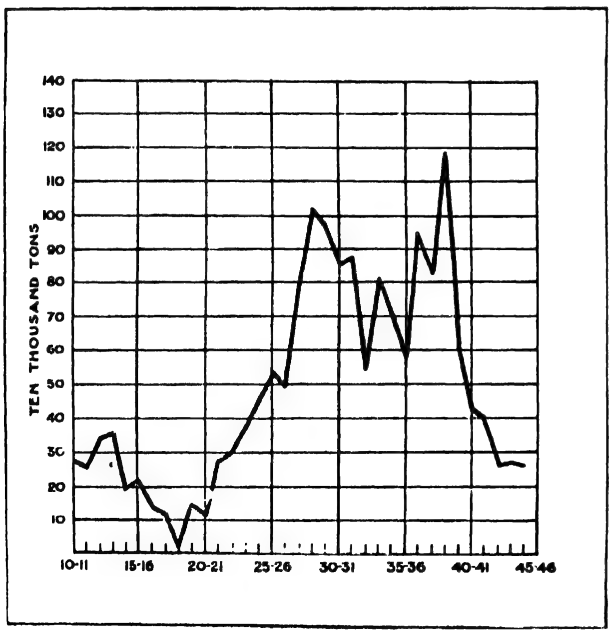
TABLE XIV

ANNUAL EXPORTS OF GROUNDNUTS FROM INDIA (MOSTLY KERNELS)

Qty. in 1,000 tons and val. in lakhs of Rs.

Year	British India		Kathiawar ports		Total	
	Qty.	Val.	Qty.	Val.	Qty.	Val.
'33-34/'37-38 (Average)	565	809	54	78	619	887
'38-39	835	993	162	190	997	1,183
'39-40	549	719	85	113	634	832
'40-41	339	406	85	4	424	410
'41-42	395	488	4	6	399	494
'42-43	258	513	5	11	263	524
'43-44	241	822	25	111	266	933
'44-45	215	631	46	161	261	792

EXPORTS OF GROUNDNUTS (MOSTLY KERNELS) FROM INDIA



After the conclusion of the Ottawa Agreement (1933) which gave a 10% preference to imports of groundnuts from Empire countries, exports to the U.K. increased from 31,643 tons in '32-33 to an annual average of 96,000 tons (17% of total exports) in the quinquennium ending with March '38. During '34-38, the U.K. obtained 60% of her requirements from India, and the rest from Nigeria, Gambia and other Empire countries.

The bulk of exports from India is in the form of kernels. Madras and French ports export mainly kernels of Coromandel type, while Bombay ports export Peanuts, Bold and Red Natal kernels. The Kathiawar ports export both kernels and nuts in shell, the latter in recent years amounting to nearly 30% of their total exports. These nuts are of the Bold variety. They are specially clean and attractive and are hand-picked for edible purposes. They fetch a higher price which permits their export in shell in spite of heavier freight.

TABLE XV

DISTRIBUTION OF INDIAN EXPORTS AMONG THE MAJOR IMPORTING COUNTRIES, AND EXPORTS FROM THE PRINCIPAL PORTS
(In 1,000 tons)

	U.K.	France	Germany	Nether-lands	Italy	Belgium	Other countries	Share of Madras	Share of Bombay
'33-34/'37-38 (Average)	96	135	90	126	67	24	27	485	80
'38-39 . . .	96	150	115	232	35	66	141	766	69
'39-40 . . .	108	99	53	126	19	47	95	471	76

Interprovincial trade in groundnuts involves less than $1\frac{1}{2}\%$ of the total production in India. Madras, Bombay, Bombay States, Hyderabad and Mysore, which are surplus areas, supply the demands of Bengal, the C. P. and Sind, in addition to meeting their own export demands. The U. P., the C. P., Rajputana and Central India States, besides meeting their own requirements, supply for edible purposes, deficit areas like Bihar, Orissa and the Punjab. Interprovincial movement takes place both by rail and sea (*vide* Table XVI).

TABLE XVI

INTERNAL TRADE (RAIL AND RIVER-BORNE)*
(In 1,000 tons)

	Averages for the triennial ending in '38-39	'41-42	'42-43§	'43-44§
Imports—				
Bombay	150·6	201·1	224·3	218·1
Madras	53·8	18·3	12·8	38·3
Bengal	19·6	49·3	17·9	31·0
Others	15·9	28·1	30·2	24·7
	239·9	296·8	285·2	312·1
Exports—				
Madras	47·9	129·5	100·3	87·5
Hyderabad	147·6	129·0	144·3	185·7
Mysore	25·4	18·9	10·7	11·3
Bombay	1·6	1·0	1·8	7·0
Others	17·4	18·4	21·9	20·6
	239·9	296·8	285·2	312·1

* The Food Statistics of India, 1946, 98 ; § Estimates.

There is a small coastal trade between Madras, Bombay, Bengal and Sind. Movement by road is insignificant except in the case of Hyderabad which exports approximately 40,000 tons annually, by road to Bombay, Madras and Mysore. Bombay is the biggest importer by rail, and Hyderabad and Madras are the largest exporters.

Prices : The rates ruling in the London market for groundnut (Coromandel pure) are a fair index of world prices. Prices during '21-27 varied between £20–27 per ton. There was then a continuous fall till it reached £8 per ton in April, '34. The main reasons, for the downward trend, were the low price of butter, increased whale-oil production, the general fall in price levels, heavy exports from India and Africa, and import restrictions in France. Prices recovered during the next 3 years ('34-35/'36-37), but went down again in '37-38 due to selling pressure from India, and the fall continued into the following year.

TABLE XVII

MARKET PRICES PER TON OF GROUNDNUT KERNELS

Year	London (Coromandel) £ s. d.	Madras (Coromandel) Rs.	Bombay (Bombay bold) Rs.
'38-39	10 6 6	110/8	109/11
'39-40	12 18 3	130/6	136/8
'40-41	16 5 0	104/14	120/8
'41-42	18 11 0	119/13	135/12
'42-43	27 3 0	231/8	266/4
'43-44	36 7 4	344/14	365/13
'44-45	32 3 0	285/5	296/12
'45-46	34 11 0	317/5	337/13

Before the outbreak of World War II, there was again an upward trend due to heavy purchases. In the first few months of the War, the rise was temporary and was mainly due to psychological reactions, but later prices began to rise rapidly owing to increased demand for oil-seeds, and registered a peak level at £43 per ton in May, '43. Since then prices have remained high, and towards the end of February, '46, when the Government of India imposed ban on exports of groundnut, owing to food shortage, the price was £38 per ton.

The *Indian Tr. J.* gives the prices of machine-decorticated Coromandel kernels at Madras, and of Bold kernels at Bombay. Prices at these centres are a fair index of Indian prices of different varieties of groundnut. Madras prices generally follow London prices and are influenced by exporters' buying limits and are often below parity. In Bombay, oil-millers' demands and organised future trading, also influence prices, which are often higher than London prices. Prices at Madras are quoted per candy of 500 or 530 lb. (2% damaged), and at Bombay, per cwt. (4% refraction).

Prices in Indian markets generally followed those prevailing at London up to the outbreak of World War II, and the reasons for fluctuations were similar. In '40-41 there was a drastic fall due to closure of European markets, especially France, and increased freight and insurance charges. Price movements in the subsequent period were similar to those in London, and the peak was reached in May, '43 when the prices of Coromandel, and Bold kernels were Rs. 93 per candy of 500 lb. (Rs. 416/10 per ton), and Rs. 24/4 per cwt. (Rs. 485 per ton) respectively. This was due to extensive purchases by the British Ministry of Food, heavy demand from oil-mills, and speculation. Towards the end of May, '43 prices began to decline as a result of the ban placed by the Government of India on forward trading, and the seizure of stocks in Bombay city and suburban areas, by the Government of Bombay. The fall continued till June, '45; in July, when there was again an upward trend, the prices were Rs. 84/2 per 500 lb. (Rs. 376/4 per ton), and Rs. 24/4 per cwt. (Rs. 485 per ton). Prices of nuts in shell were similar.

Prices of groundnuts show seasonal depression, especially during harvesting period. The producer is adversely affected as he sells the bulk of his crop at the harvesting time (Aug.–Dec.) and very little is left with him to market when prices improve in Dec.–Jan., and again between June and August. Depressions are more marked in the case of nuts than in the case of kernels.

The prices fetched by different varieties do not always correspond to their oil content. In Bombay, Khandesh fetches a higher price than Coromandel, Karad and Bold, while in Hyderabad, Coromandel fetches more than Khandesh, even though the latter variety has a higher oil content.

Oil : Groundnut oil is the cheapest and most extensively used vegetable oil in India. In addition to its direct use for edible purposes, it forms the basis for the manufacture of vegetable ghee. The chief centres of its production are Madras, Hyderabad and Bombay. Bombay also imports large quantities of groundnut oil from other areas in order to meet the demand of her vegetable oil industries. The other major importing areas are Bengal, U.P. and Delhi.

TABLE XVIII

INTERPROVINCIAL TRADE IN GROUNDNUT OIL*

(In tons)

Trade Block	Exports '42-43	Exports '43-44	Imports '42-43	Imports '43-44
Assam . .	11	6	204	1,018
Bengal . .	532	417	11,905	18,566
Bihar . .	86	462·5	1,612	3,188
Orissa . .	537	1,036·5	2,058	3,287
U. P. . .	500	277·5	20,965	16,063
Punjab . .	204·1	153	3,800	4,134
Delhi Province	372	580	6,483	11,022
C. P. & Berar .	2,244	4,339	7,029	6,841
Bombay .	18,617	19,500	36,564	34,121
Madras . .	46,289	52,822	2,299	2,615
Central India	88	65	3,534	2,262
Nizam's Territory .	31,266	25,100	331	327
Mysore . .	1,287	2,026	4,951	3,341
Others . .	97	427	516	547
Total .	101,939	107,210	102,251	107,332

**Inland (Rail and River-borne) Tr. India*.

According to the estimates of the Food Dep., Govt. of India, in '46-47, the following were the surpluses available in the major producing areas: Madras, 145; Hyderabad, 80; W. I. States, 48·3; C. P. and Berar, 2·6; and Mysore, 2 thousand tons. Out of this amount 142,000 tons were allotted to *vanaspati* factories, 59,400 tons for general consumption in deficit areas, and 48,000 tons for export.

Other countries which import the oil are the U.K., Mauritius, Straits Settlements, Ceylon, etc. In '42-43, exports to Canada, Mauritius and Ceylon were 4,980, 1,090 and 1,030 tons, respectively.

The price of groundnut oil was lowest in '38-39 when it was Rs. 7/5 per maund at Madras. Since '41-42 there has been an upward trend, but prices fell slightly in the following two years, and again rose in '45-46. In March, '46 the prices went up to Rs. 38/13 per maund at Bombay, and Rs. 33/15 at Madras. Market prices in Madras and Bombay usually show similar trends.

TABLE XIX

ANNUAL EXPORTS OF GROUNDNUT OIL FROM INDIA

(Qty., in tons and val. in lakhs of Rs.)

	British Indian Ports		Kathiawar Ports		Total	
	Qty.	Val.	Qty.	Val.	Qty.	Val.
'32-33/'36-37 (Average)	2,162	7·25	1,217	4·42	3,379	11·67
'37-38	9,536	33·66	2,670	9·53	12,206	43·19
'38-39	16,000	48·14	2,151	9·50	18,151	57·64
'39-40	16,159	51·59	250	0·78	16,409	52·37
'40-41	35,813	128·58	121	0·37	35,934	128·95
'41-42	26,385	93·35	64	0·25	26,449	93·60
'42-43	8,504	41·79	160	0·97	8,664	42·76
'43-44	537	3·62	148	1·45	685	5·07
'44-45	608	5·62	56	0·38	664	9·00

Compared with the quantities of the oil produced in India, exports are insignificant (7·5% of production during the quinquennium ending '37-38).

In the quinquennium ending '41-42, the shares of Madras and Bombay in the export trade of groundnut oil from British India were 83·3 and 14·7% respectively. The share of Madras became prominent after '37, when exports to Burma began to be shown in the *Annu. Statt. Sea-borne Tr. India.*

Exports from Kathiawar ports were small till '34-35 (<100 tons). In '35-36 they exceeded 2,500 tons due to the development of the crushing industry in Kathiawar, and reached a peak level of 3,300 tons in '36-37.

Burma is the biggest customer of Indian groundnut oil (65·6% in the quinquennium ending '41-42).

TABLE XX

PRICES OF GROUNDNUT OIL

(Rs. Per maund)

	Madras	Bombay
'38-39	7/5	7/13
'39-40	9/8	10/4
'40-41	13/1†	10/4*
'41-42	10/13‡	12/9*
'42-43	17/15‡	22/14*
'43-44	28/1‡	31/14*
'44-45	26/15	30/4*
'45-46	27/12	31/11*

*Mon. Statt. Wholesale Prices Selected Articles. †Export Price. ‡ *Capital.*

Oil-cake The average annual production of groundnut cake during the quinquennium '33-34/'37-38 was nearly 500 thousand tons. Of this quantity, nearly 280 thousand tons (56·6%) were retained in India, and the rest exported. Since '40 the production of groundnut cake in India increased rapidly owing to expansion of the oil crushing industry. Export, however, dwindled as a consequence of the War, and in '43-44 out of a production of 770 thousand tons of cake, only 19 thousand tons were exported. This resulted in an extension of the use of groundnut cake as a manure, in place of imported chemical fertilizers. During '44-45 the estimated requirements of Bombay, Madras, and Hyderabad were 271,000, 289,700 and 80,000 tons, respectively.

Most of the groundnut cake produced in India is used in or around the areas of production, and consequently interprovincial movement of cake is small. In '46-47, out of a total production of a million tons, arrangements were made for the movement of only 86,000 tons.

TABLE XXI

ANNUAL EXPORTS OF GROUNDNUT CAKE FROM INDIA
(Qty. in 1,000 tons and val. in lakhs of Rs.)

	British India		Kathiawar ports		Total	
	Qty.	Val.	Qty.	Val.	Qty.	Val.
'33-34/'37-38 (Average)	185	119	34	20	219	139
'38-39 . . .	365	241	54	34	419	175
'39-40 . . .	232	159	43	19	175	178
'40-41 . . .	139	55	12	5	151	60
'41-42 . . .	82	24	17	5	99	29
'42-43 . . .	54	35	12	5	66	40
'43-44 . . .	14	12	5	4	19	16
'44-45 . . .	Nil	Nil	2	2	2	2

Exports of cake from British India have shown a steady rise. They increased from 17,000 tons in '20-21 to 92,755 tons in '26-27 : but for a temporary set-back in '32-33, they continued to rise further up to '38-39. The average annual exports during the quinquennium ending '37-38 amounted to 219,000 tons (43·4% of production).

The U.K. is the biggest customer of Indian groundnut cake. After the grant of Imperial Preference in '33, her imports from British India increased from an annual average of 33,500 tons during '28-29/'32-33 to a peak of 182,556 tons in '38-39. The U. K. was also the principal customer of the exports of cake from Burma which amounted to 54,200 tons annually during the quinquennium ending in '37-38.

Germany, Netherlands and Belgium along with Sweden, Norway and Denmark which began to figure prominently as importers of Indian groundnut cake in the immediate pre-War period ('38-39) stopped their purchases during the war.

Bombay ports exported over 50%, and Madras about 25% of the total exports from British India in the decennium ending in March '43.

The U.K. is the principal importer of cake from Kathiawar ports, and her share of exports from these ports during the quinquennium ending March '38 amounted to 73·5%.

The chief markets for groundnut cake are Calcutta, Bombay, Malkapur (Berar) and Raichur. Prices at Raichur are the lowest, and at Calcutta, the highest. *Ghani* cake fetches a higher price than expeller cake.

In Calcutta, the cake was quoted at Rs. 1/13 per maund in '40-41. The price rose sharply in '43-44 and touched a peak level of Rs. 8/8 per

TABLE XXII

DISTRIBUTION OF EXPORTS FROM BRITISH INDIA AND SHARES OF PRINCIPAL INDIAN PORTS (1,000 tons)

	U.K.	Ceylon	Germany	Netherlands	Belgium	Other countries	Exports from Bombay	Exports from Madras
'33-34/'37-38 (Average)	105	8	34	14	17	7	127	53
'38-39	183	6	80	29	23	45	225	127
'39-40	136	14	17	5	4	53	139	85

Rep. Marketing Groundnuts India & Burma, 1941, 42.

maund in August '44. Later, for some time the controlled price was Rs. 5/10 per maund.

TABLE XXIII

PRICES OF GROUNDNUT CAKE (PER MAUND)

	Calcutta	Bombay
	Rs.	Rs.
'38-39 .	2/2	2/3
'39-40 .	2/3	2/3
'40-41 .	1/13	1/6
'41-42* .	1/11	1/1
'42-43* .	2/12	1/15
'43-44* .	6/9	..
'44-45* .	7/0	..
'45-46* .	5/7	..

* *Capital.*

ARALIA Linn. ARALIACEAE

A genus of shrubs and small trees, comprising 35 species distributed in India, Malaya and North America. 8 species occur in India. *A. cachemirica* Decne. (D. E. P., I, 287; Fl. Br. Ind., II, 722) found in the basin of the Jhelum and the Chenab, is said to be eaten by goats. A few species are grown in gardens for their variegated foliage.

The leaves of *A. spinosa* Linn. (N. America) and *A. montana* Blume (Java) have been found to contain saponin (Burkill, I, 211).

ARAUCARIA Juss. PINACEAE

D. E. P., I, 289; Fl. Br. Ind., V, 644.

A genus of evergreen trees, reaching a gigantic stature of 100-200′, and a girth up to 8–10′. It includes about 15 species distributed in Australia and South America.

Most of the species are hardy, and symmetrical and bear a strikingly characteristic elegant habit. Ornamental species like *A. cookii* R. Br. ex D. Don, *A. cunninghamii* Ait. (Hoop Pine), *A. excelsa* R. Br. (Norfolk Island Pine) and *A. imbricata* Pav. (Monkey Puzzle), have been introduced into India. *A. cunninghamii*, native to South America, is a valuable timber tree (Imp. Inst. Lond., Descriptive list of some Empire Timbers, 1928, 12), and also yields a resin (Smith, *J. Soc. chem. Ind., Lond.*, 1911, **30**, 1359). The timber of this species is useful for cabinet work, joinery, general construction work and plywood manufacture.

ARCTIUM Linn. COMPOSITAE

Fl. Br. Ind., III, 359.

A genus of herbs, comprising about 4 species distributed in temperate Asia and Europe. *A. lappa* Linn. (Burdock), is an erect herb, 2-4′ high, found in western Himalayas, from Kashmir to Simla at 6,000–9,000′. Its roots are said to possess diuretic, diaphoretic and alterative properties. In Europe, they are used in skin affections and gout. In the U.S.A., a tincture of the seeds is used in the treatment of psoriasis, acne and prurigo (Martindale, I, 320).

The roots contain about 45% inulin. The leaves and roots contain volatile oil. The yield from the former is 0·03%, and from the latter 0·07–0·18% (Wehmer, II, 1260). The seeds contain Arctiin, $C_{27}H_{34}O_{11}.H_2O$, a glucoside (Omaki, *Chem. Abstr.*, 1939, **33**, 582, 1716).

ARDISIA Sw. MYRSINACEAE

D. E. P., I, 290; Fl. Br. Ind., III, 518.

A large genus of shrubs or small trees, comprising about 260 species, distributed in tropics. 45 species occur in India and about 10 are reported to be useful. The roots of *A. colorata* Roxb., *A. crispa* (Thunb.) DC. (syn. *A. crenata* Roxb.), *A. solanacea* Roxb. (syn. *A. humilis* Vahl.), *A. odontophylla* Wall. and *A. villosa* Roxb. are used in the Malay Peninsula and other Eastern countries for diarrhœa, fever and rheumatism. The leaves of *A. crispa* and *A. solanacea* are eaten as salad (Burkill, I, 218). The berries of the latter are said to yield a yellow dye.

ARECA Linn. PALMAE

A small genus, comprising about 20 species of slender palms. The genus is essentially Indo-Malayan, distributed in tropical Asia, New Guinea and tropical Australia. Four species are known to occur in India and one is endemic in Ceylon

(*A. concinna* Thw.). *A. catechu* yields the areca or betel nut. The seeds of *A. concinna*, *A. nagensis* Griff. (Naga hills, Assam), and *A. triandra* Roxb., (the Andaman Islands and Sumatra) are occasionally used as substitutes for areca nuts.

A. catechu Linn. ARECA NUT, BETEL NUT

D. E. P., 1, 291 ; C. P., 83 ; Fl. Br. Ind., VI, 405 ; Blatter, Pl. 92.

SANS.—*Poogiphalam* ; ARAB.—*Fofal* ; PERS.—*Popal* ; HIND., etc.—*Supari* ; TEL.— *vakka* ; TAM. —*Pakku* ; KAN.—*Adike* ; MAL.—*Adakka*.

This is a tall slender palm, with a smooth whitish stem reaching a height of 40–60′. The stem is surmounted by a crown of pinnate leaves, 4–6′ in length, in which the upper pinnæ are confluent. The lower portion of the petiole is expanded into a broad, tough, sheath-like growth. The inflorescence is a spadix encased in a spathe, and comprises a much branched rachis which bears both male and female flowers. The former are small and numerous, while the latter are much larger. The fruit is generally ovoid, about 1½–2″ across, and 2–2½″ long, and is brightly orange when fully ripe. The pericarp (65%) is hard and fibrous, and the kernel (seed, 35%), called the areca nut, is about 1–1½″ in diameter and greyish-brown in colour. It is hard and has reddish-brown lines because of its ruminate albumen. (Pl. XIX, 1)

The areca palm is considered to be a native of Malaya, where it is cultivated on an extensive scale. It is found throughout the East Indies and the Philippines. In India, it is cultivated in the coastal regions of southern Bombay and Madras, Mysore, Bengal and Assam. Although it is a maritime species, it thrives in areas up to 250 miles from the coast and at altitudes up to 3,000′. It is also grown in Ceylon and Burma and it has been extended to Madagascar and East Africa.

The fruits and nuts vary greatly in size and shape. The hardness and astringency of the nuts also show considerable variations. Some nuts are large, flat, and are almost bitter. Others are conical or spherical, and so bland in taste as to be called 'sweet areca nuts'. According to Venkata Rau (*J. Bombay nat. Hist. Soc.*, 1915, **23**, 793), they are from *A. catechu* var. *deliciosa*. There are also nuts which produce tightness in the throat and profuse secretion of mucus. These are not restricted to any particular locality, and occasionally good and bad nuts are found on the same tree (Burkill, I, 225). These and other differences are probably of a varietal character (Brown, I, 144), or due to the influence of soil and climate.

Several types, some of which are known by local names ('Ram supari', 'Shrivardhani', etc.), are of commercial importance, and markets show distinct preferences. In general, it may be said that types, which on curing yield a shapely top-half, moderately thick and slightly depressed in the centre, are considered to be superior.

CULTIVATION

This palm requires a moist tropical climate for luxuriant growth and is very sensitive to drought. It thrives in areas with heavy rainfall (200 inches) provided drainage is good, and also in drier areas (20 inches), if suitably irrigated. It is a shade loving plant, especially in earlier stages, and is generally grown as a mixed crop with fruit trees such as the plantain and the coconut. Sometimes it is also grown in the midst of mango, jack, and guava trees.

A. catechu thrives on a variety of soils such as the laterite soils of the West Coast, the alluvial soils of Bengal and Assam, and the dark fertile clayey loams in the drier parts of Mysore. But saline or alkaline soils, lands with much admixture of *kankar* nodules, calcareous segregations and light and sandy soils are not suited to it.

The areca palm is carefully cultivated in Mysore and the methods adopted there are generally found throughout south India and on the West Coast. In Mysore, the palm is grown both in the *malnad* areas (hill tracts) on the Western Ghats, which receive a rainfall of over 200 inches, and in the irrigated parts of the *maidans* (plains) where the rainfall is often only 30 inches. In the *malnad*, plantations are usually located in the valleys of hills adjoining tropical forests, whereas in the *maidan* they are found near tanks and rivers.

Seedlings are raised from ripe fruits collected in November, from carefully selected trees, about 25–30 years old. Prior to sowing, they are dried for a day or two. They are then planted in well-prepared nursery-beds covered with leaf mould, or they are tied up in plantain sheaths with rich moist soil, and allowed to germinate, before they are

planted out. Seedlings are transplanted when they are about 2 years old. In India, areca is rarely planted *in situ*.

In a young plantation, it is usual to plant about 400 trees per acre. After some 20 years, fresh seedlings are planted between rows, and between trees, in order to replace older trees when they become unproductive. Thus some of the older garden contain 800–1,200 trees per acre, or even more.

The principal features of cultivation in *malnad*, are the provision of drains for removing excess of rain-water, and channels for irrigation during summer. After the preparation of the soil, plantain trees are planted about 8′ from one another in rows 14-16′ apart. After a year, areca seedlings are transferred to well-prepared pits, 8′ apart, in the same row as plantain trees. The latter, in addition to being a profitable catch-crop, act as a wind-break and supply shade to areca seedlings. When the plants are well established, pepper vines are trained on them and cardamom root-stocks are planted in the channels. The earth round the base of the trees is dug up every year and covered with leaves, twigs and fresh earth (5 cart-loads per acre). This is necessary to prevent exposure of roots resulting from the washing away of the soil by heavy rains.

In *maidan* areas, provision for drainage is unnecessary, but arrangements have to be made for irrigation. As a mixed crop betel vine (*Piper betel*) is grown instead of cardamoms and pepper.

Farm-yard manure at ten cart-loads per acre, is applied every year. In addition to this the application once in three years of 780 lb. of a mixture of groundnut cake (200 lb.), ammonium sulphate (80 lb.), super-phosphate (200 lb.), and potassium sulphate (300 lb.), has been found beneficial. Leaf manure and green manure are also used frequently.

In Bengal, in the earlier stages of plantation, *Erythrina indica* is utilised for shade and betel vines are trained on the trees in some of the northern districts. In general, very little trouble is taken in maintaining the estates beyond adding some manure and giving an occasional top-dressing with earth.

In Mysore, areca takes 10–12 years to come into bearing. In Bengal, trees planted near villages may begin yielding in 6–7 years, but in plantations, crops are said to be obtained only after the tenth or twelfth year. In Ceylon, the tree is said to give a good yield in the 8th year. Till recently no attention seems to have been given to the cultivation of areca in Ceylon. The Ceylon varieties are heavy yielders, but the nuts are usually smaller in size (Kanangara, *Trop. Agriculturist*, 1941, **96**, 96). In general the areca palm takes 30 years before a plantation reaches maturity. The fruiting life of a tree may be put at 30-60 years after maturity, and a tree may live for 60-100 years.

The areca leaves, usually 4–7, begin to drop from December onwards, at intervals of about 3 weeks, up to June, and the inflorescences (spadices covered with spathes) appear from the axils of such leaves. In a season usually not more than five spadices appear and the average is about two to three. The spathes open soon after the shedding of the leaves and the fruits ripen 10-11 months later. In Mysore, harvesting season is from Aug.–Jan.; in Bengal, from Oct.–Jan.; in Bombay and Ceylon, from August–March. In each season two or three pickings are made.

Each tree yields 2–3 bunches a year, containing 200–250 fruits, weighing 3·2–4·9 lb. per 100 fruits. The yield per acre, with 400 trees in bearing, is 160,000–300,000 fruits, or about 6-10 cwt. of dried areca nuts. In Mysore the average yield per acre of cured nuts is estimated at 7 cwt. per annum, and the net profit from an acre in normal times (1937), at about Rs. 100/-.

Bengal and Assam have the largest acreage under areca in India. In other areas the acreage is: Bombay, 22,700; Madras, 108,600; Mysore, 34,500; Ceylon, 68,500; and Burma, 30,750.

In Mysore, the areca palm suffers from two serious fungus diseases: *Kole roga* and *Anabe roga*. The former is due to *Phytophthora omnivora*, var. *arecæ* and the latter to *Ganoderma lucidum* Leyss. ex Fabr. *Kole roga* is prevalent in Shimoga dist., and in southern Bombay. It manifests itself during the heavy rains of the south-west monsoon. The symptoms are the rotting, and consequent shedding, of immature nuts. If not prevented in time the fungus attacks even the crowns of palms and brings about the death of trees during two or three seasons. This disease is estimated to cause an annual loss of nearly 4 lakhs of rupees.

Two remedial measures are adopted. The first is to give a protecting cover against excessive moisture to each bunch of fruits by a hood called *kotte*, made from two expanded leaf petioles of the palm, suitably skewered together. This affords only very partial relief. A more efficient method now adopted almost invariably, is spraying the bunches with 2% solution of Bordeaux mixture (5 lb. each of $CuSO_4$ and CaO, in 25 galls. of water) to which is added an adhesive mixture of casein and lime (½ lb. casein in ½ gal. water + ½ lb. lime slaked in ½ gal. water). Usually spraying is done only once in the season, but it has to be repeated if the nuts begin to shed badly.

Anabe roga is prevalent in the drier plains of Mysore. The fungus attacks roots and stem bases, rendering them dry and brittle. The symptoms are poor growth of the crown, and yellowing of the leaves. In later stages, bracket-shaped fructifications appear at the basal regions of the palms, and even well-grown trees are killed out. The remedial measures are, the destruction of dead and diseased portions and the subsequent applications of sulphur dust at the rate of ½–1 lb. per palm on an isolated ring of land, which includes suspected trees as well. This disease is common in gardens where considerable lime is present in the shape of small nodules.

In Palghat and Coimbatore (Madras), and in Assam (*Dep. Agric., Assam, Leafl.*, No. 24, 1938), a fungus disease attacks the stems of plants, resulting in the exudation of a dark brown liquid from splits in them. The disease is similar to the stem-bleeding disease of the cocoanut and has been traced to *Thielaviopsis paradoxa*. The only remedial measure appears to be the removal of all diseased tissues and the application of hot tar to cut surfaces (Von Hon, *Bull. imp. Inst. Agric. Res., Pusa*, No. 169, 1927).

ARECA NUTS

Areca nut is used either raw or cured. The latter kind is used mostly in southern India, and the former, in the rest of the country. For marketing raw nuts, only ripe fruits are collected, as kernels from these are less astringent and keep better. They are then husked, or cut into two, dried, and the half-nuts are removed from shells. Sometimes ripe fruits are dried in the sun for six to seven weeks and marketed as such and peeled before use.

The curing of nuts is a speciality of Mysore and is also practised to some extent in the Coimbatore and Palghat dists. Curing improves the colour of the nuts, their taste and keeping quality, and it brings them to the correct degree of palatability by removing excess of tannin and mucilage. The percentage of tannin in raw nuts is 21·6–30·2, and in the cured nuts, 8·6–15·1. At the same time, during curing the nuts acquire a uniform colour by infusion of tannin into mottled parts and become sufficiently soft and tender for chewing.

For curing, the fruits are gathered while they are only three quarters ripe and the husk is still green. At the proper stage they are moderately firm to touch, and the thumb-nail can be pressed through the husk up to the kernel. If the fruits are under-ripe, the cured product is poor and shrunken in appearance, and if over-ripe, hard and light-coloured.

The main cropping season in Mysore is from August–January. During the first plucking in August, a quarter of the crop is collected; the major portion is gathered in the second plucking during October or November; and finally a small harvest is collected up to January. Immediately after collection, the fruits are shelled and the kernels sliced. The fruits should not be left unhusked for more than three days. During shelling, care is taken to obtain unbruised kernels with the thin membranous tissue covering them intact. They are then sliced into two by cutting across, or chipped into finer pieces.

In the next stage, the kernels are boiled in a mixture of water and the previous year's extract of the nuts, called *chogaru* for 1½–3 hours, over a steady fire. Usually copper or earthenware vessels are employed. When the kernels are sufficiently boiled, the embryo drops out, and the cut surfaces assume a slightly concave appearance. The kernels are then removed by means of perforated ladles and dried in the sun for 6–9 days.

The decoction obtained by boiling the nuts with fresh water can be used for three or four changes when *chogaru* of the correct consistency is obtained. This is sometimes dried in the sun and preserved for the following year's boiling. The best

quality of *chogaru* is obtained by reboiling nuts which have already been boiled once in water.

If *chogaru* is not available, the practice is to add to the first charge an extract of various materials, such as the barks of *Eugenia jambolana*, *Pterocarpus santalinus*, *Ficus religiosa*, etc., together with a few betel leaves and some slaked lime. Sometimes a little gingelly oil (*Sesamum indicum*) and jaggery are also added. The former gives a shine to cured kernels.

Various modifications of the above process of curing are in use. In one, the fruits are boiled without husking, and are then peeled, sliced, and dried. In another, the kernels are cut into thin slices like wafers, and boiled as before. Sometimes various spices are added to the boiling mixture. Occasionally kernels are reboiled in milk to cater to fastidious tastes.

Three varieties of cured nuts are found in the market. *Batlu* (plate) variety consists of kernels cut across into two halves. Pieces from embryo ends fetch a higher price. *Chooru* (pieces) consists of kernels sliced into smaller pieces, and the best of them is *laranga chooru*, which resembles cloves. *Idi* (whole) is from nuts boiled without slicing. The cured kernels of *batlu* and *chooru* classes always fetch a higher price than the *idi* type. The out-turn of the first two is 20–25% less than that of the last. Certain local varieties such as *Deshavar*, *Ramachandrapur*, etc., named according to the centres of production, are also recognised in the trade.

The grading of areca nuts in Mysore follows an elaborate system. There are three principal grades distinguished by their colour and hardness. *Hasa*, the superior quality, is from nuts collected at the right stage of maturity. The highest grades are called *pheton* and *rajalu*. *Chikni*, belongs to the second class and the nuts are darker and somewhat shrunken in appearance. *Bette*, the last class is of light colour and is somewhat harder, because of the more woody texture of ripe nuts from which it is obtained. The price offered for any particular lot will depend upon the proportion of the three grades in it. Still another grade, called *gotu* is of the poorest quality and is from the ripest nuts. It is very hard and coarse, and is often sold in husk. The prices of *hasa*, *bette* and *gotu* are in the proportion 9 : 3–5 : 2.

WHOLESALE PRICES OF ARECA NUTS

Market	Price per cwt.		Price per maund (82 lb.)	
	Mar. 1941	Mar. 1945	Mar. 1941	Mar. 1945
	Rs.	Rs.	Rs.	Rs.
Calcutta	10/15–13/1	71/0	8–9/8	52/0
Patna	11/5	84/11	10/8	62/0
Bangalore (Cured)	42/10	113/11	31/3	83/3

Areca nuts contain: moisture, 31·3; protein, 4·9; fat (ether extract), 4·4; carbohydrates, 47·2; mineral matter, 1·0; Ca, 0·05; P, 0·13%; Fe, 1·5 mg./100 g. (*Hlth. Bull.*, No. 23, 1941, 43). The following constants are recorded for the petroleum ether extract: m.p., 36–38°; sp. gr./15°, 0·973; sap. val., 234·6; iod. val., 12·3 (Jamieson, 130). It consists mostly of the glycerides of lauric (ca. 50%), myristic (21%) and oleic (upto 29%) acids (Wehmer, I, 123).

Catechin, $C_{15}H_{14}O_6 \cdot 4H_2O$, m.p., 96° (anhydrous m.p., 175°) has been isolated from the nuts (Wehmer, 1935, 21).

Of the several alkaloids present in the nuts, the most active is arecoline, $C_8H_{13}O_2N$ (about 0·1%), a strongly alkaline, colourless and odourless liquid, b.p., 220°. The others are arecaidine, $C_7H_{11}O_2N$, guvacoline, $C_7H_{11}O_2N$, guvacine, $C_6H_9O_2N$, etc. According to continental pharmacopoeias, the seeds should contain not less than 0·4% of alkaloids calculated as arecoline.

Areca nut is extensively used as a masticator throughout India, Burma, Ceylon and Malaysia. It is generally chewed along with *pan* (leaves of *Piper betle*) and a little slaked lime, to which *katha* (from *Acacia catechu*), spices and tobacco are sometimes added. Ready-made chewing preparations like these, called *beedas* are sold in the bazar. Chewing develops salivation and the saliva is coloured red. It is supposed to prevent the decay of teeth, but its continued use blackens and loosens them. The constant irritation of the mucous membrane of the mouth sometimes results in oral carcinoma (Chopra, 284). The fresh nuts have intoxicating properties and produce giddiness. The juice of tender nuts, in small doses, acts as a laxative (Koman, 1919, 12). The burnt nut is used as a dentifrice.

Areca nut has long enjoyed a reputation in India and China as an anthelmintic in man and animals, and was for sometime included in the B. P. But recent experimental investigations have not been able to confirm this property of the nuts (Caius and Mhaskar, *Indian J. med. Res.*, 1921-22, **9**, 206; see also Chopra, *loc. cit.*). The nut is mildly astringent and is now used chiefly in veterinary practice as a vermifuge for tapeworm. The dosage for dogs is 2 grains per lb. of body weight.

Of the alkaloids of areca nut, arecoline is the only one which exhibits toxic properties. It acts on the central and peripheral nervous system, producing paralysis which may be preceded by convulsions. Its hydrobromide is recognised by some Continental pharmacopoeias, and is given hypodermically (dose, 1 grain) as a cathartic for horses. It is also employed as a tænicide in dogs in oral doses of $\frac{1}{16}$-$\frac{1}{2}$ grain.

The green kernels yield an extract containing about 67% of tannin (Baens, *Chem. Abstr.*, 1941, **35**, 6143; *vide* also *Indian For. Leafl.*, No. 72, 1944, 5). *Chogaru* contains tannins and is occasionally sent from the producing areas to the Bombay market as a variety of catechu.

A large quantity of husks is obtained during the preparation of kernels for the market. The husk contains 47·6% of cellulose on the dry basis, and is composed of a mass of weak woolly fibres, mixed with coarser and stronger bristle-like fibres. Attempts at the utilisation of husks for the preparation of paper have not proved successful. They may perhaps be employed with longer-fibred materials for the production of low grade brown papers and cardboard (*Bull. imp. Inst., Lond.*, 1922, **20**, 289). The decomposition of husks in the soil is extremely slow, and even after a year the highly lignified fibres do not rot. They form a good mulching material.

A. catechu is one of the most handy forms of wood in rural parts. Its stems are used in various ways in house-construction; pillars, joists, reapers, etc. The petioles, or the large expanded sheaths at the lower ends of leaves, are commonly used as packing material and for making *kottes* to protect the inflorescence, against excessive moisture. The spathe is tough and impervious to water, and finds several domestic uses. The inflorescence is used in ceremonies on auspicious occasions.

The production of areca nut in India is not sufficient to meet the internal demand and large quantities are imported from the Straits Settlements, Ceylon, Java, etc.

AVERAGE ANNUAL IMPORTS

Year	Qty. cwt.	Val. Rs.	Price per cwt. Rs.
During the quinquennium ending			
'33-34 . .	1,215,658	1,60,86,139	13·2
'38-39 . .	1,492,089	1,32,86,499	8·6
'43-44 . .	931,131	1,16,29,670	12·5
In '44-45 . .	143,551	73,71,483	51·4
,, '45-46 . .	162,263	70,69,854	43·6

The percentage distribution of imports was: Bengal, 67·5; Bombay, 17·6; and Madras, 14·7.

There is also a small export of the nuts from India:

AVERAGE ANNUAL EXPORTS

Year	Qty. cwt.	Val. Rs.	Price per cwt. Rs.
During the quinquennium ending			
'33-34 . .	3,370	1,54,397	45·8
'38-39 . .	65,320	7,91,846	12·1*
'43-44 . .	77,295	10,46,048	13·5*
In '44-45 . .	1,718	2,58,668	150·5
,, '45-46 . .	5,025	6,49,527	129·3

* Before 1937 mostly high grade cured areca nuts used to be exported from Madras and Bombay to S. Africa, E. Africa, Aden, etc. Since the separation of Burma, the large exports of low grade nuts from Calcutta to Burma are included in the statistics of foreign trade, and this has brought down the average prices.

ARENARIA Linn. CARYOPHYLLACEAE

A genus consisting of 100 species of annual or perennial herbs, distributed in northern temperate regions. 24 species are said to occur in India. *A. holosteoides* Edgew. (D. E. P., I, 301; Fl. Br. Ind., I, 241) is a tall, slender, much-branched

herb found in the western Himalayas and Tibet, from Kumaon to Kashmir (7,000–12,000′). It is said to be used as vegetable in Chumba and Ladak.

Saponin is reported to occur in some species (Roberg, *Chem. Abstr.*, 1937, **31**, 4768).

ARENGA Labill. PALMAE

A genus of tall stout palms, comprising about 10 species, mostly occurring in tropical Asia, Malaya and Australia. In India, *A. pinnata* and *A. wightii* Griff. are indigenous, and *A. obtusifolia* Mart. has been introduced as an ornamental palm.

A. pinnata (Wurmb.) Merril Syn. *A. saccharifera* Labill. SUGAR PALM OF MALACCA, GOMUTI PALM

D. E. P., I, 302; Fl. Br. Ind., VI, 421; Blatter, 351, Pl. 60.

TAM.—*Kichilippanai*; BURMA—*Toung-ong*.

This palm has a trunk 20–40′ high with long ascending pinnatisect leaves forming a diffuse crown. The black leaf-sheaths which cover the tree trunk are fibrous. The pendulous, solitary inflorescence, 3–4′ long, appears first on the topmost leaf-axil and later spreads downwards. Male and female flowers occur generally on separate peduncles, but rarely together. The fruits are obovoid, globose, 2–3 seeded with uniformly thick semi-pulpy kernel.

A. pinnata, though rare in India, is common in Malaya, where people cultivate it in the neighbourhood of their houses and villages. It is found wild in parts of Assam, Burma and south China.

It is the principal sugar-yielding palm of Malaya, and hence its old specific name. The tree reaches maturity in about 6–10 years, and produces a floral axis 6–10′ long, covered by a big spathe from the topmost leaf-axil. During flowering, starch from the stem is transformed into sugar and is transported to the growing axis of the inflorescence. When the floral axis emerges from the spathe, after about 70 days, the male spadix is chosen for tapping. Female spadices do not yield any sugar.

Tapping is carried out by beating the male floral axis with a wooden rod for 3–4 days to ensure the flow of sap into the wounded part. A small notch is then made in the peduncle by chipping it. The exudate is collected like *nira*, from coconut palm, in earthen pots previously heated and smoked, or smeared with *chunam* (slaked lime) to sterilize them, and removed every 6 hours. The syrup is collected in this manner, day after day for nearly two months or more, removing fresh chips from the same peduncle. Once flowered, the tree goes on producing spadices for 2–3 years till the lower-most axil of the leaf is utilized and the tree is exhausted. On an average each tree yields about ¾ of a gallon of juice per day.

The syrupy liquid exuded from the peduncle is rich in sugar and is easily fermented. The unfermented syrup is boiled and cooled to form jaggery which in Malaya is called *gula* Malacca. The fermented liquid is used as toddy, and the over-fermented juice yields *sirka* or vinegar.

Milsum and Dennett (*Malay. agric. J.*, 1929, **17**, 449) found that 100 c.c. of the juice ($d/84°$F., 1·0315) contained: saccharose, 7·10 g.; invert sugar, 0·15 g.; non-sugars, 0·29 g.; nitrogen, 0·005 g.; and ash, 0·021 g. The density is usually 1·02–1·03 and the corresponding sugar content, 5·1–7·9 %. The ratio of sucrose to invert sugar is high and the yield of juice per plant is considerable. Crystallized sucrose of pale yellow colour and good quality may be obtained by concentrating the juice under reduced pressure. On an average one gallon of juice gives 1 lb. of *gula* Malacca. It is relished by Malays on account of its peculiar flavour, although it is dark and sticky, due to albuminoids, pectins and gums.

The trunk of the tree contains a large amount of starch. But it is difficult to extract it from the pith on account of the fibre bundles. This starch is used in the form of sago in the western and poorer parts of Java and Malaya. But it is inferior in quality to true sago, obtained from *Metroxylon sagu* Rottb. Trunks of female plants are preferred for extracting sago. In the case of male plants sago is extracted only after the removal of toddy (Burkill, I, 231). Each plant yields about 154 lb. of sago (Blatter, 357).

The tender leaves and sweet pith are edible. The black reticulate leaf sheaths covering the tree trunks have hair-like smooth fibre. It is used for caulking boats in China. Its softer parts catch fire readily and hence it is used for lighting fire. The sheaths are reticulate and when tied together closely can serve as sieves. The coir

obtained from the petiolar sheaths does not deteriorate in contact with water and is used for cordage. The coarse parts of the fibre are used for making brushes.

The kernel of the fruit is edible. The juice of the outer fleshy covering of the fruit is corrosive and causes pain and inflammation, if it comes in contact with the skin. It contains a large number of raphides. The juice is also said to act as a fish poison (Burkill, I, 234). The trunk is hard and durable, and becomes hollow as the tree grows old. It is used as water-trough or channel.

A. wightii (Travancore, Mysore, near Jog falls, Coimbatore and the Nilgiris) and *A. obtusifolia* also have sweetish pith which is edible, and their leaves are also eaten when tender (Blatter, 358). The floral shoot of *A. wightii* (called *Dhudasel* in Kanarese), when cut, is said to yield toddy (Brandis, 48).

ARGEMONE Linn. — PAPAVERACEAE

A genus of prickly herbs, including about 12 species native to tropical America, and whence it has been introduced into other tropical countries. *A. mexicana* is the only species found in India.

A. mexicana Linn. PRICKLY POPPY, MEXICAN POPPY

D. E. P., I, 306; Fl. Br. Ind., I, 117; Kirt. & Basu, Pl. 54.

SANS. & TEL.—*Bramhadandi*; HIND.—*Bharband*; BENG. *Siyal-kanta*; TAM.- *Kudiyotti*; KAN. —*Datturi*; MAL.—*Ponnummattam*.

An annual with prickly leaves, bright yellow flowers, and bristly capsules, containing many seeds resembling black mustard seeds (*Brassica nigra*). It is an American plant which has run wild in India and is now a troublesome weed.

The seeds yield 22–36% of a nauseous, bitter non-edible oil. It is considered a remedy for skin diseases. In small amounts (10–30 minims) it is a cathartic. In larger doses, it causes purging and vomiting.

The seeds are sometimes found mixed with black mustard. Argemone oil in edible mustard oil is probably responsible for outbreaks of epidemic dropsy (Chopra, Pasricha, Goyal, Lal and Sen, *Indian med. Gaz.*, 1939, **74**, 193, and Lail, Mukerjee, Roy and Sankaran. *Indian J. med. Res.*, 1939, **27**, 207). Its presence is detected by the rich orange red colour developed, when concentrated nitric acid is added to the oil or its mixtures (Dymock, Warden & Hooper, I, 119).

The plant contains berberine and protopine (Santos and Adkileu, *J. Amer. chem. Soc.*, 1932, **54**, 2923).

The oil (29·4% of seeds) has the following constants: sp. gr./25°, 0 9209; $n_D^{60°}$, 1·4601; sap. val., 190; iod. val., 120; acid val., 12·0. The mixed acids consist chiefly of oleic (22%) and linolic (48%) acids and some contain palmitooleic (about 6%) and ricinoleic (about 10%) acids (Iyer, Sudborough and Ayyer, *J. Indian Inst. Sci.*, 1925, **8**, 29).

The oil is used as an illuminant and lubricant, and in medicine for external application in skin diseases. Mixed with dyeing oils such as linseed oil it may be used in the paint industry (*Bull. imp. Inst., Lond.*, 1922, **20**, 292).

The oil cake cannot be used as cattle fodder because of residual oil. However, it could be utilized as a fertilizer (crude protein, 24·6%; *Bull. imp. Inst., Lond., loc. cit.*).

The seeds also are considered medicinal. Taken in large quantities, they are said to be poisonous. The yellow juice which exudes when the plant is injured is used externally in scabies, and in ophthalmia.

ARGYREIA Lour. — CONVOLVULACEAE

A genus of climbers, including about 40 species, mostly confined to tropical Asia and Africa, of which 25 occur in India. Some are medicinal.

A. speciosa Sweet THE ELEPHANT CREEPER

D. E. P., I, 310; Fl. Br. Ind., IV, 135.

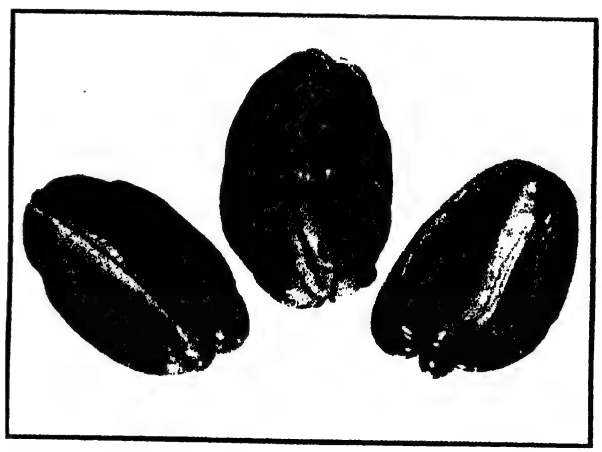
SANS.—*Samudrapalaka*; HIND.—*Samandar-ka-pat*; BENG.—*Bichtarak*; MAR.—*Samudra soka*; S. INDIA—*Samudrapala*.

A woody climber, found throughout India (except in the dry western regions) up to an elevation of 1,000′. The root is regarded as alterative and tonic, and is said to be useful in rheumatism and diseases of the nervous system. The under surface of the leaf is densely pubescent, and is an irritant. It is used to promote maturation of boils, and as a rubefacient in skin diseases.

1. ARISTOLOCHIA INDICA

2. ARTABOTRYS ODORATISSIMUS

3. ASTERACANTHA LONGIFOLIA



4. AVERRHOA CARAMBOLA (FRUITS)

The leaves of *A. fulgens* Choisy, and *A. malabarica* Choisy, find similar uses. The roots of the latter are said to be cathartic (Chopra, 463).

ARISAEMA Mart. ARACEAE

D. E. P., I, 311.

A genus of herbs, including about 105 species distributed in temperate and tropical Asia, Abyssinia and North America. 40 species occur in India.

The corms of some species, rich in starch, are a useful stand-by during famines. The roots of *A. tortuosum* Schott are used to kill worms which infest cattle.

A. concinnum Schott

Fl. Br. Ind., VI, 505.

A cormatous herb, found in the temperate Himalayas, between Garhwal and Bhutan at 6,000–10,000′.

The Lepchas feed pigs on the corms. They are rich in starch, but contain crystals of calcium oxalate and are highly irritant. They are rendered edible by repeatedly boiling them with water and discarding the water used.

They are said to be used as food during famine. Dutt (*J. Asiat. Soc., Bengal,* 1909, **5**, 197) gives the following analysis of the air-dried corm: moisture, 8·5; albuminoids, 7·7; fat, 1·4; carbohydrates, 65·9; fibre, 8·9; ash, 7·6 (Ca, 1·2; P_2O_5, 0·2%).

A. speciosum Mart.

D. E. P., I, 312; Fl. Br. Ind., VI, 500; Kirt. & Basu, Pl. 994.

PUNJAB—*Samo-ki-khumb, kiralu, kiri-ki-kuri.*

A cormatous herb, 2–4′ high, found in the temperate Himalayas from Kumaon to Sikkim and Bhutan at 6,000–8,500′.

The corms are similar to those of *A. concinnum.* Dutt (*loc. cit.*) gives the following percentage composition: moisture, 7·6; albuminoids, 3·8; fat, 1·6; carbohydrates, 76·0; fibre, 6·1; ash, 5·1 (Ca, 1·0; P_2O_5, 0·5%).

In Kulu, the root is given to sheep for colic.

ARISTIDA Linn. GRAMINEAE

D. E. P., I, 312; Fl. Br. Ind., VII, 223.

A genus of slender, annual or perennial grasses, comprising about 160 temperate and sub-tropical species. About 12 species are known to occur in India. These are low grasses with little foliage and are characterised by narrow, awned spikelets. They grow on open dry situations, even on poor shallow soil, in the drier regions of India.

A few like *A. adscensionis* Linn. (syn. *A. depressa* Retz.), *A. hystrix* Linn., *A. funiculata* Trin. & Rupr., etc., when tender, are grazed by cattle. *A. adscensionis* grown in Africa is reported to contain 13% of protein (Bor, *Indian For. Rec., New Series, Bot.,* 1941, **2**, 73).

Some species like *A. setacea* Retz., are used for making brooms and tatties (screens) like those made from khus-khus roots (*Vetiveria zizanioides*).

ARISTOLOCHIA Linn. ARISTOLOCHIACEAE

A large genus of herbs or twining plants, comprising about 300 species, found mostly in the tropical and temperate regions of the world. 8 species are reported to occur in India. The aristolochias are bitter and poisonous and generally contain alkaloids; a few are medicinal and were formerly reputed to be useful in the treatment of snake-bites. Some exotic Brazilian species such as *A. fimbriata* Cham., *A. elegans* Mast., and *A. ornithocephala* Hook., are among the ornamental creepers found in Indian gardens.

Serpentaria, B. P. consists of the dried rhizome and roots of *A. reticulata* Linn. (Texas, Lousiana, etc.). It is now mainly used as an aromatic bitter. *A. serpentaria* Linn. (Virginian snake root), *A. longa* Linn., and *A. rotunda* Linn. (Europe) have been similarly used. In India, *A. bracteata*, *A. indica* and *A. tagala* Cham. are medicinal.

A. bracteata Retz. THE BRACTEATED BIRTHWORT

D. E. P., I, 314; Fl. Br. Ind., V, 75; Kirt. & Basu, Pl. 820A.

SANS.—*Dhumra-patra*; HIND.—*Kiramar*; GUJ.—*Kidamari*; MAR.—*Kidemar*; TAM. & MAL.—*Aduthinapalai*; TEL.—*Gadidha-gadappa*; KAN.—*Adumuttada-gida.*

A slender perennial herb, found in the Upper Gangetic plain, Bengal, the western Peninsula, and in the north-west up to Bundelkhand. It

grows abundantly on the black soil of the Deccan and Gujarat.

The plant is exceedingly bitter and is reputed to possess cathartic and anthelmintic properties. The expressed juice of the leaves is said to destroy maggots when applied to foul and neglected ulcers. According to Koman (1920, 2) the bruised leaf mixed with castor oil is applied externally in obstinate cases of eczema on children's legs, and a decoction of the root was found to be generally efficacious in expelling round-worms.

A. indica Linn. THE INDIAN BIRTHWORT

D. E. P., I, 315; Fl. Br. Ind., V, 75; Pl. XVII, 1.

Indian names generally from SANS.—*Ishvari mul* (root); ARAB. & PERS.—*Zaravandehindi*; GUJ.—*Arkmula*; MAR.—*Sapasan*.

A shrubby or herbaceous twiner with a woody root-stock, found throughout the low hills and plains of India from Nepal and lower Bengal to Chittagong, in the Deccan Peninsula from Konkan southwards, and in Ceylon up to 3,000′.

In indigenous medicine, the roots of *A. indica* are used for the treatment of snake-bites, fevers, and minor ailments of children such as flatulence and dyspepsia. According to Koman (1920, 2) the *vaidyans* in the Tamil country use this drug in malarial fevers, but a decoction of the roots did not give satisfactory results. The powdered root in honey is reported to be given for leucoderma, and the juice of the leaves is regarded as a specific for cobra-poisoning (cf. Mhaskar and Caius, *Indian med. Res. Mem.*, 1931, No. 19, 18).

Aristolochia, included in the B. P. C. (1934), consists of dried stem and root of *A. indica*. In the East, it is used in the form of a tincture as a bitter for the same purpose as serpentary (*A. reticulata*).

The roots have been found to contain an alkaloid, aristolochin, $C_{17}H_{19}O_3N$, a yellow bitter principle isoaristolochic acid $C_{17}H_{11}O_7N$ and allantoin. The aroma of roots is due to an essential oil (0·5%) composed of sesquiterpenoid compounds together with a trace of camphor (Krishnaswami, Manjunath and Venkatarao, *J. Indian chem. Soc.*, 1935, **12**, 476; 1937, **14**, 39).

Arrowroot, Wild or East Indian— see **Curcuma angustifolia**

Arrowroot, West Indian— see **Maranta arundinacea**

ARSENIC ORES

D. E. P., I, 321; C.P., 92.

ORPIMENT: SANS.—*Pinda hari-tala*; ARAB.—*Zarnikh-asfar*; PERS.—*Zarnikh-zard*; HIND.—*Hartal*; BENG.—*Horital*; GUJ.—*Artal*.

Orpiment (As_2S_3; As, 61%), realgar (As_2S_2; As, 70·1%), and arsenical pyrites or arsenopyrites (FeAsS; As, 46·0%) are the principal ores of arsenic found in India and Burma. Löllingite ($FeAs_2$) and its variety, leucopyrite (Fe_3As_4), are reported to occur in small amounts in the mica pegmatites of Bihar.

Orpiment and realgar (sp. gr., 3·5; H., 1·5–2·0), are soft minerals which fuse readily in a candle flame. Orpiment is lemon-yellow, whereas realgar is red or orange. On exposure, realgar changes into orpiment and arsenolite (As_2O_3). These minerals occur either as hot spring deposits or as volcanic sublimates, or in veins associated with antimony ores.

Orpiment (natural and artificial) is used as a pigment in the manufacture of lac-ware, and in lacquer work. Mixed with gum, powdered orpiment gives a golden colour, and mixed with indigo, it gives a beautiful green colour. In Hindu medicine, it has been regarded as an alterative and febrifuge, and is used in skin diseases, and as a depilatory. Realgar (natural and artificial) is employed as a pigment in calico-printing, dyeing and tanning. It burns with an intense white light and hence it is used in fire-works.

Deposits of orpiment and realgar have long been known and worked in Chitral (N.W.F.P.), where they are found at altitudes of 11,000-16,000′ (*Rec. geol. Surv. India*, 1940, **75**, *Prof. paper* No. 2, 14). During recent years, however, only small quantities of orpiment have been obtained from this area and there are no records of production. A promising deposit of realgar occurs near Partsan village (36°3′ : 71°51′) in Chitral. The mineral occurs in the form of scattered particles and in nests in calcareous shales along the strike, over a width varying from a few inches to several feet.

In the Kumaon area of the United Provinces orpiment has been reported from near Munsyari (80°18′ : 30°7′), and both orpiment and realgar occur on the surface moraine of the Shankalpa glacier (80°24′ : 30°19′).

Arsenical pyrites (arsenopyrite or mispickel), FeAsS (sp. gr., 6·1 ; H., 5·5–6·0), has a metallic lustre. Fresh surfaces are silver-white and on exposure become tarnished and copper-red. The mineral occurs in veins connected with igneous intrusions associated with the ores of lead, silver, copper, cobalt, nickel or tin. During the smelting of these ores, arsenic is obtained as a by-product in the form of As_2O_3.

An important deposit of arsenopyrites occurs in an one-foot seam with chalcopyrite (copper pyrites) on the northern flank of Sampthar hill (26°58′: 88°34′), in the Kalimpong area, Darjeeling dist., Bengal (LaTouche, 14). Stray occurrences of arsenopyrites have also been noticed in Kashmir (Middlemiss, Miner. Surv. Rep., Jammu & Kashmir, Non-metallic Miner., 1930, 54). In Jaipur State, a mixture of cobaltiferous arsenopyrites and cobaltite known as *sehta* is found along with copper ores near Khetri at Batai and Bagor mines (*Trans. Min. geol. Inst. India*, 1935, **29**, iv, 335). Small amounts of the mineral also occur in some of the wolfram-cassiterite lodes of Burma. Nickel speiss obtained at Nam Tu is reported to contain a considerable proportion of arsenic (Geol. Surv. India, Indian Minerals, Ores, etc. for Industr. Purposes, 1942, 4).

Crude oxide of arsenic (As_2O_3, 92–96%) is obtained during the smelting of arsenical ores. This is refined to white arsenic (As_2O_3, 99%), which forms the principal source of the element and its compounds. On reduction with charcoal it yields the element which is a brittle steel-grey metalloid (sp. gr., 5.7) with a brilliant lustre (b.p., 450°–sublimes). Small quantities of arsenic are used in hardening lead used for making lead shots, and it is also a constituent of some alloys. The element and its salts are poisonous.

White arsenic is extensively used in the preparation of insecticides and fungicides such as lead arsenate and copper aceto-arsenite (Paris green), and weed-killers (sodium arsenite). It is now being used also for the preservation of wood. In the glass industry, white arsenic is employed as a decoloriser to remove the green colour due to iron. It is used in preserving hides, and as an antiseptic.

The world's production of white arsenic is about 55,000 tons, to which the United States, Mexico, France and Sweden together contribute more than 75%. Before the War ('39-45) India's requirements of arsenic and its oxides were being met mainly by imports from Burma, Hongkong, Belgium, Germany, China and Japan. In 1939 imports from Burma were over 50% of the total imports.

AVERAGE ANNUAL IMPORTS OF ARSENIC AND ITS OXIDES INTO BRITISH INDIA

		Qty. Cwt.	Val. Rs.
In quinquennium			
ending	'33-34	2,388	99,483
,,	'38-39	4,061	97,574
,,	'43-44	3,280	71,128
In	'44-45	535	13,785
,,	'45-46	2,034	52,861

ARTABOTRYS R. Br. ANNONACEAE

A genus of scandent shrubs, comprising about 30 species, distributed in tropical Africa and eastern Asia. The flowers are strongly scented and the berrylike fruits of a few African species are said to be edible. 10 species occur in India.

A. odoratissimus R. Br. = *A. uncinatus* (Lam.) Merril

D. E. P., I, 322 ; Fl. Br. Ind., I, 54 ; Pl. XVII, 2.

SANS.—*Harachampaka* ; BENG.—*Kat champa* ; MAR.—*Hirra champha* ; S. INDIA—*Madan mast, manoranjitam*.

A large climbing ornamental shrub, indigenous to India and Ceylon. Its flowers, though not showy, are highly fragrant. The plant is grown in gardens throughout eastern Asia. It is reported to be medicinal in the Philippine Islands (Burkill, I, 243).

A. suaveolens Blume

D. E. P., I, 322 ; Fl. Br. Ind., I, 55 ; *Ann. R. bot. Gdn. Calcutta*, 1893, **4**, Pl. 61.

A large woody climber, found in Eastern Bengal and Assam, and distributed eastwards to the Philippine Islands.

In East Indies, a decoction of the leaves is said to be used in cholera (Burkill, *loc. cit.*).

The root and stem bark have been found to contain two crystalline alkaloids, artabotrine, m.p., 187°, and suaveoline, m.p. 182° (Henry, 654).

Recently Barger and Sargent (*J. chem. Soc.*, 1939, 991) have been able to isolate a third alkaloid, artabotrinine, an amorphous base. Maranon (*Philip. J. Sci.*, 1929, **38**, 259) has found artabotrine to be toxic to guinea-pigs.

ARTEMISIA Linn. COMPOSITAE

A large genus of small herbs, comprising some 280 species found in the Northern Hemisphere. They are abundant in arid regions notably in the western United States and in the Asiatic steppes. They are also found in South Africa and South America. About 34 species occur in the temperate region of north-western Himalayas.

Artemisias are bitter aromatic herbs or low shrubs, often with much-divided leaves and inconspicuous flowers borne on numerous small heads. Some of them are medicinal and are the source of the valuable anthelmintic drug, santonin (0·5–3%). Several species yield essential oils, and a few are reported to be useful as fodder.

Artemisia, as an anthelmintic and stomachic, was long in use amongst the Greeks and Romans. The Persian and Arabian physicians also employed it for the same purpose, and even to this day it is similarly used by the Yunani physicians in India. There is, however, no mention of this drug in ancient Sanskrit works on medicine. Levant worm-seed, the pressed dried unexpanded flower-heads of *Artemisia*, probably of *A. cina* Berg called 'Santonica', was used in Europe for intestinal worms till about 1830, when Kahler discovered its active principle, santonin, and the latter was first included in the B.P. in 1864.

The chief source of santonin is *A. cina* Berg which grows in abundance in Russian Turkistan, particularly in Chimkent. Several other artemisias such as *A. mexicana* Willd., *A. neo-mexicana* Woot. and *A. wrightii* A. Gray, occurring in America, and *A. gallica* Willd. found in east Germany, France, England and Scotland, and *A. maritima*, a fairly widely distributed species, have been found to contain santonin. But the American and English species are too poor in santonin for commercial extraction (*Bull. imp. Inst., Lond.*, 1934, **32**, 33). *A. fragrans* Willd. and *A. parviflora* Roxb. occurring in Afghanistan have also been reported to contain santonin (Qazilbash, *Chem. Abstr.*, 1935, **29**, 7019).

In India, *A. maritima* occurring in certain areas of Kashmir and Kurram, has been found to contain santonin, and is used for its extraction. Some artemisias are of medicinal interest and a few are prized for their volatile oils.

A. absinthium Linn. THE ABSINTHE, WORMWOOD

D. E. P., I, 323; C. P., 93; Fl. Br. Ind., III, 323; Bentley & Trimen, Pl. 156.

ARAB. & PERS.—*Afsanthin*.

This is an aromatic and bitter herb found in Kashmir at 5,000-7,000′. It is distributed over northern Asia, Afghanistan, and extends westward to the Atlantic. It is now naturalized in eastern Canada and is cultivated in the United States.

The essential oil of *A. absinthium* (about 0·3%) used to be a constituent of 'absinthe', but its addition is now prohibited. The commercial oil (sp. gr./25°, 0·917–0·942) is produced in America and its chief constituents are thujone and thujyl alcohol (Finnemore, 844). Wormwood oil has a tonic and stimulating effect on the digestive organs and is sometimes used externally. The plant also contains a bitter glucoside, absinthin, and a crystalline compound, m.p., 165°(Wehmer, II, 1245).

The dried leaves and the flowering tops of the plant are medicinal. Its tincture (B.P.C.) is used as a tonic and digestive.

A. annua Linn.

Fl. Br. Ind., III, 323.

A strongly scented annual found in the Punjab from Peshawar to Waziristan, ascending to 5,000′. It also occurs in Afghanistan and north-eastern Asia. The plant is reported to yield about 0·3% of essential oil composed principally of artemisia ketones, pinene, cineole, *l*-camphor, etc. (Wehmer, II, 1243).

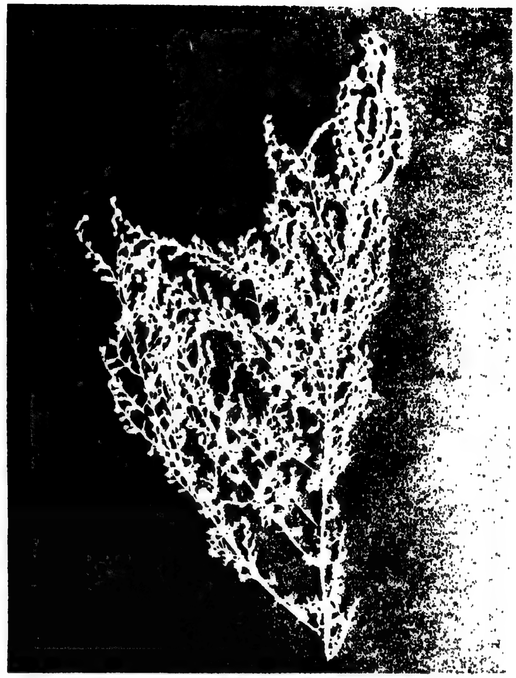
A. dracunculus Linn.

Fl. Br. Ind., III, 321.

A perennial herb found in western Tibet (14,000-16,000′) and in Lahul. It is distributed to Afghanistan, western Asia, south and middle Russia.

The herb contains about 0·3% of essential oil which has an anise-like odour. Both the leaves and the essential oil are used for flavouring vinegar, and as spice. The plant is cultivated in France for its essential oil known as 'Oil of Taragon' (sp. gr.,

1. ARTEMISIA PALLENS



ARTEMISIA MARITIMA

3. ARTEMISIA MARITIMA FORMA RUBRICAULE, GROWN IN DEHRA DUN

4. ARTEMISIA MARITIMA GROWING WILD IN GURAIS VALLEY, KASHMIR

0·949 n_D, 1·517 ; $[\alpha]_D$, +7·8°). The chief constituent of the oil is methyl chivacol (60–70%). It contains also some *p*.-methoxycinnamic aldehyde (Finnemore, 848).

A. maritima Linn. WORMSEED, SANTONICA

D. E. P., I, 324 ; C.P., 93 ; Fl. Br. Ind., III, 323 ; Pl. XVIII, 2.

ARAB. *Shik* ; PERS.—*Dirmanah* ; KURRAM – *Spirato, tarkhah* ; HIND.—*Kirmala* ; MAR.—*Kirmaniowa*.

A shrubby aromatic species, about 3½′ high with a woody root-stock ; stems, erect or ascending and much branched from the base. It is an exceedingly variable plant, with erect or drooping flower-heads.

It is found in the western Himalayas from Kashmir to Kumaon, at 7,000-9,000′. It is widely distributed all over the northern hemisphere of the Old World.

This is the only santonin-bearing species occurring in India. This species is common in several areas of north-western India, such as Kashmir, Kurram, Kagan, Bushaher, Waziristan, etc. But plants growing only in certain areas of Kashmir and Kurram have been found to contain santonin. In these areas santonin-free plants are also found. Badhwar (Report on Kurram *Artemisias* from the Santonin Standpoint, 1934) has observed that in the earlier stage of growth santonin-bearing plants in Kurram have red stems, while santonin-free plants have green stems, and that both turn brown as they grow older. He has called the former, *A. maritima* forma *rubricaule*. (Pl. XVIII, 3 & 4).

SANTONIN

For profitable utilisation the herb should contain not less than 1·2% of santonin (*Bull. imp. Inst., Lond.*, 1934, **32**, 40). Indian artemisia is generally poorer in santonin than Russian *A. cina* from Turkistan, which is reported to contain 2·3 3·6%. The santonin content of artemisia from Kashmir has been reported by several workers to vary from 1–2% (*Bull. imp. Inst., Lond.*, 1923, **21**, 316 ; Krishna and Varma, *Quart. J. Pharm.*, 1933, **6**, 23), and that of artemisia from the Kurram Valley, from 1-1·6% (Badhwar, *loc. cit.*). The quantity of artemisia available in Kashmir has been estimated at over 180 tons per annum (Chopra and Ghosh, *Indian J. med. Res.*, 1926, **13**, 533), and at about 25 tons per annum in the Kurram Valley (Badhwar, *loc. cit.*, 20). Since these estimates were made, owing to the introduction of the cultivation of *A. maritima* in these areas, it is possible that the quantities now available are larger.

The technical assay of artemisia for santonin is carried according to a modification of the method of Greenish and Pearson (*Pharm. J.*, 1921, **106**, 2). 100 g. of the dried leaves and flower heads finely crushed, are extracted with chloroform. After removal of the solvent from the extract, the residue is treated with saturated barium hydroxide. The alkaline extract is acidified with hydrochloric acid, and santonin taken up with chloroform. At this stage some of the associated resins are removed by washing with 5% ammonia. Chloroform is then distilled over, and the residue crystallized from 15% alcohol. The crystals are washed, dried, and weighed, and a correction is applied for the solubility of santonin in dilute alcohol.

Artemisias are xerophytic plants. In Central Asia they grow in semi-desert areas where extremes of temperature, both high and low, prevail. The plants prefer a saline sandy soil. Analyses of soils in Kurram, where santonin containing artemisia grows show that such soils have a high available potash content and are rich in silt and fine sand (Krishna and Varma, *loc. cit.*). A semi-arid climate and a saline sandy soil appear to be best suited to its cultivation.

Efforts have been made to grow santonin-rich artemisia in upper Kurram. The plants raised from seeds or root cuttings appeared to flourish well, specially those grown on ridges (Badhwar, *loc. cit.*). The area under cultivation in Kurram Valley has been greatly extended (Qazilbash, *Indian J. Pharm.*, 1943, **5**, 161 ; Raheja, *Indian Fmg.*, 1942, **3**, 504).

A study of the seasonal variation of santonin in Kurram artemisia showed that up to about the second week of June santonin is concentrated only in leaves and reaches a maximum between the end of May to the end of June, when flower buds begin to appear. Thereafter santonin passes into the buds. The maximum in buds is attained when they are fully developed, just before they open—between the 10th of August and the 10th of September. With the opening of buds there is a rapid fall in santonin content (Badhwar, *loc. cit.*). This is similar to what has been reported

in the case of *A. cina*, the Russian artemisia. In these plants also the flower heads are collected in July and August, before the buds open.

For extraction of santonin, the crushed material is first subjected to steam distillation to obtain the volatile oil present in it. It is then treated with milk of lime, when santonin forms the soluble salt, calcium santoninate. The filtered solution is reacted with sodium hydroxide and the calcium salt is converted to the sodium salt. Carbon dioxide is passed in to precipitate calcium as carbonate, which is removed by filtration. On acidifying the warmed filtrate containing sodium santoninate and cooling the solution, santoninic acid separates out, and immediately lactonises to santonin. The precipitate is filtered, dissolved in alcohol, decolorized by animal charcoal, and finally purified by recrystallization (Denston, 134).

Russia still holds the monopoly of production and trade in santonin. A limited quantity of it is being produced from Kashmir and Kurram artemisia. Most of the Kashmir artemisia is extracted by Messrs. Kashmir Pharmaceutical Works, in a factory located at Baramulla, Kashmir. The factory produces nearly 2,200 lb. of santonin per year from about 100 tons of *Artemisia*. The Bengal Chemical and Pharmaceutical Works, Calcutta, and Messrs. Mehta Brothers of Amritsar, also produce some santonin. The bulk of santonin bearing artemisia of Kurram is sold to Messrs. T. & H. Smith of England. The total internal consumption in India is estimated at 1,000–1,200 lb. a year, and in 1945, the price per ounce was Rs. 14–16.

Santonin, $C_{15}H_{18}O_3$ is a neutral colourless crystalline substance (m.p., 170–172°; $[\alpha]_D$, –171·4°, in chloroform). It is sparingly soluble in water and cold dilute alcohol, but readily dissolves in hot alcohol, chloroform and benzene. On exposure to sunlight, it turns yellow owing to the formation of photosantonin. It is therefore preserved in coloured bottles.

Baldwin has isolated from the Indian plant, in addition to santonin, 2 more crystalline constituents: β–santonin of much weaker anthelmintic action, and pseudo-santonin, which is devoid of anthelmintic properties (Denston, 134). Artemisin, $C_{15}H_{18}O_4$, is another bitter principle reported to occur in *A. maritima* (Wehmer, II, 1248).

Santonin is very efficient in its action on round worms, less effective on thread worms and has no action on taenia. In ascaris, a combination of santonin and chenopodium (5 grains of santonin with 1 c.c. of chenopodium oil) is more effective than either of these drugs given separately (Maplestone and Mukerjee, *Indian med. Gaz.*, 1931, **66**, 627).

Santonin is usually administered in very small quantities (1–3 grains in the evening, followed by castor oil or saline purge in the morning). It causes (yellow vision) xanthopsy and sometimes also violet vision. In larger doses it induces headache, nausea, vomiting and convulsions. Cases of fatal poisoning have been reported, and death takes place from cardiac and respiratory failure (Hale White, 114).

All the varieties of *A. maritima* contain essential oils which vary both in quantity (2–3%), and in composition. The commercial oil, a by-product of santonin factories, is a thick yellow oil (sp. gr., 0·915–0·940; $[\alpha]_D$,–1·5 to 8°; n_D, 1·465–1·469). The essential oil from the Turkistan variety has been found to contain cineole, 27·8, and thujone, 7–8% (Wehmer, *loc. cit.*). *A. maritima* var. *kazakewicz* yields an oil (0·6%) which contains 36% of camphor (Wehmer, 1935, 22).

A. pallens Wall. ex DC.

Fl. Br. Ind., III, 329; Pl. XVIII, 1.

MAR., TAM. & KAN.—*Davana*.

An aromatic annual found in certain parts of south India, specially in the Mysore State. It is also cultivated in the neighbourhood of Poona.

Its fragrant leaves are used in floral decorations. The yield of oil has been found to be 0·22–0·58% (cohabation method). The oil (sp. gr./15·5°, 0·9605; $n_D^{20°}$, 1·4880, $[\alpha]_D$,+35°; acid val., 2·4; ester val., 52·9; sol. in 10 vols. of 70% alcohol) has been appreciated by the perfumery trade in America where it used to be sold at Rs. 350–400 per lb. (1940–41).

The plant is now grown on a small scale near Mysore city from a carefully selected strain. Considerable care is necessary in its cultivation, and in harvesting the crop.

A. sacrorum Ledeb.

Fl. Br. Ind., III, 326; Kirt. & Basu, Pl. 541B.

This species occurs in western Tibet, Kanawar and in the Tibetan regions of Kumaon (10,000–12,000′).

It is said to be given to horses for affections of the head. The plant yields 1% of essential oil, ($d/^{20}$, 0·919–0·9152 ; n_D, 1·464–1·4645), which contains cineole (19·26%), camphor (6%), etc. (Chistova, *Chem. Abstr.*, 1936, **30**, 3940).

A. siversiana Ehrh. ex Willd.

D. E. P., I, 327 ; Fl. Br. Ind., III, 329 ; Kirt. & Basu, Pl. 542A.

An annual herb, very similar to *A. absinthium*, found in the western Himalayas from Kashmir to Lahul (8,000–10,000′), and in western Tibet. It extends to China and Russia.

This plant is also said to be medicinal, and is considered to be a good fodder. The composition of milk is not affected even when it constitutes as much as 40% of the animals' feed. It contains protein, 15·5 ; and fat, 5·12%, with digestive coefficients of 62·2 and 71·4% respectively (Kopuirin, *Chem. Abstr.*, 1933, **27**, 3759).

A. vulgaris Linn. INDIAN WORMWOOD, FLEABANE

D. E. P., I, 327 ; C.P., 93 ; Fl. Br. Ind., III, 325 ; Kirt. & Basu, Pl. 540.

SANS. *Nagadamani* ; HIND. & BENG.—*Nagdona* ; MAR.—*Dhordavana* ; TAM.—*Machipatri*.

A tall aromatic shrub, found throughout the mountainous districts of India, ascending to 12,000′ in the western Himalayas and to 5,000–8,000′ in Sikkim, the Khasia, Ava and Martaban mountains. It grows at Mount Abu in Marwar, and on the Western Ghats from Konkan southwards to Ceylon. It is distributed to temperate Europe, Asia, Siam and Java.

In Indian medicine, the leaves and flower tops are administered in the form of an infusion in cases of nervous and spasmodic affections (Kanny Lall Dey, 38). It is also said to be antiseptic, expectorant and anthelmintic (Chopra, 464).

The plant yields about 0·2% volatile oil (Wehmer, II, 1244). A sample of the oil from plants collected in Bengal had the following constants : sp. gr., 0·9222 ; $[\alpha]_D$, −8°52′; $n_D^{20°}$, 1·462, and contained α-thujone (Finnemore, 858). This oil has been found to be a good larvicide like kerosene, although it is only a feeble insecticide (Chopra, Roy and Ghose, *J. Malaria Inst., India*, 1940, **3**, 495).

ARTHROCNEMUM Moq. CHENOPODIACEAE

D. E. P., I, 328 ; Fl. Br. Ind., V, II.

A genus of 8 species of shrubs or herbs occurring in temperate or tropical coastal swamps. *A. indicum* Moq. found in Bengal, Northern Circars and Bombay, is a common mangrove. It is said to be used to treat scorpion stings (Chopra, 464 ; cf. also Caius and Mhaskar, *Indian med. Res. Mem.*, No. 24, 1932).

ARTHROPHYLLUM Blume ARALIACEAE

Fl. Br. Ind., II, 733.

A genus of trees or shrubs including about 10 species, distributed in the Indo-Malayan region. The wood of *A. ovalifolium* Jungh. & De Vriese (syn. *A. diversifolium* Blume), a small tree found in the Andamans and South-east Asia, is very light and is probably of no value even as fuel. Boorsma (ex Burkill, I, 247) has found a non-poisonous alkaloid in the leaves of a segregate species, *A. blumeanum* Zoll. & Moritzi.

Artichoke, Globe—see **Cynara scolymus**

ARTOCARPUS Forst. MORACEAE

A genus of evergreen or deciduous trees, comprising about 100 spp., distributed in the Indo-Malayan region and China. 18 spp. occur in India of which *A. chaplasha*, *A. hirsuta*, and *A. lakoocha* are important timber trees.

A. integra, *A. communis* and *A. lakoocha* yield edible fruits. The fruits of *A. nobilis* Thw. (Ceylon), and *A. rigida* Blume are also eaten. The timber of these two species is used for small furniture, beams, boats, etc.

A. communis Forst. = *A. altilis* (Park.) Fosberg Syn. *A. incisa* Linn. f. THE BREAD-FRUIT

D.E. P., I, 330 ; Popenoe, 406 ; Pl. XIX, 2.

MAR.—*Vilayati phanas* ; TEL.—*Seema panasa* ; TAM.—*Seema pila*.

A tall tree 40–60′ high, with large shining dark green, incised leaves, bearing prickly brownish or yellow fruits of the size of melons. Seedless and seed-bearing races are known, and the former are generally cultivated. The tree is indigenous to Malay and is cultivated in the tropics. It has been successfully introduced into Bombay, south India and Ceylon.

The tree requires a warm and humid, maritime climate and thrives best on coastal plains and can be propagated from seeds or from underground root suckers. When young, the plant grows best under shade, but later on needs full exposure to sunlight. An eight year old tree yields 700–800 fruits per year.

The bread-fruit is starchy and has a characteristic aroma. The fruit is sliced after removal of the outer rind, and baked or boiled before eating. It contains : moisture, 79·5; protein, 1·5 ; fat, 0·2 ; carbohydrates, 17·9; minerals, 0·9 ; Ca, 0·04 ; P, 0·03% ; Fe, 0·5 mg. ; vitamin A, 5 I. U./100 g. (*Hlth. Bull.*, No. 23, 1941, 38 ; *vide* also Wehmer, I, 244).

Its leaves are relished by cattle. The tree yields a latex which makes good bird-lime, and is also used for caulking boats and for painting canoes. The bark is fibrous, and strong ropes, capable of withstanding prolonged contact with water can be made from it. The extraction of fibre from the young bast, however, is laborious and is not usually undertaken (Burkill, I, 251).

The wood is moderately hard (sp. gr., 0·473), light and yellow in colour when freshly cut, but turns light brown later. It is straight or somewhat cross-grained and not difficult to work. It seasons well, and is used for beams, posts, rafters, flooring, etc.

A. chaplasha Roxb.

D. E. P., I, 329 : Fl. Br. Ind., V, 543.

BENG.—*Chaplash* ; ASSAM—*Sam* ; BURM.—*Taung-pienne* ; TRADE—Chaplash.

A tall deciduous tree 100–120′ high with a clean straight bole, 60–70′ in height, and 10–15′ in girth. The greyish-brown bark exudes a milky juice. The tree is found scattered in the moist deciduous and evergreen forests in the sub-Himalayan tract, from Nepal eastwards to Bengal and Assam, and southwards to Burma and the Andamans.

The wood is yellowish-brown, changing rapidly to brown or dark brown, after a few hours of exposure. It is light (sp. gr., 0·56 ; air-dry wt., 30–32 lb. per c. ft.), moderately hard and strong (75–80% of the strength of teak), straight or shallowly interlocked-grained, very coarse, and even-textured. Anatomically, it is characterised by large vessels, frequently occluded with chalky deposits, which show as white lines along the grain. Growth rings are indistinct and there is paratracheal zonate parenchyma. The rays are coarse and heterogenous and form a prominent fleck on the radial surface (Pearson and Brown, II, 938).

According to Trotter (1944, 52) the wood seasons easily without degrade, and kiln-seasoning offers no difficulty. Pearson and Brown (*loc. cit.*), however, mention that this timber has a tendency to develop surface cracks and splitting on account of its interlocked fibres. In air-seasoning good results are obtained by girdling the tree prior to conversion. The timber saws and works well, but on account of interlocked fibres, it requires care to bring it to a good surface. It peels well on a rotary lathe, into continuous sheets which may be used for second grade commercial plywood (*Indian For. Rec., New Series, Util.*, 1941, **2**, 84).

The timber is durable under cover, and moderately so, when exposed. It is difficult to treat, but even without treatment, it resists insect and white-ant attack much better than many common timbers. As a medium-weight wood, it is suitable for construction work (beams, wall plates, door and window frames), ship-building, etc. Being ornamental, it can be used for panelling and furniture. In Assam it is employed for carving, turnery, and to a limited extent, for tea boxes. It has been used successfully for the shanks of built-up jute bobbins. It is regarded as a first class general utility timber (Pearson and Brown, *loc. cit.*).

About 350 tons of *chaplash* in logs up to 6′ girth are available annually from Assam, and a somewhat larger quantity from Bengal. Lower Burma and the Andamans can also supply this timber. In Assam, during 1937, chaplash used to be sold in log form at Rs. 45 per ton, and as sawn material at Rs. 1/8 per c. ft. In Bengal, it used to cost Rs. 25–50 per ton (Trotter, *loc. cit.*).

A. hirsuta Lam.

D. E. P., I, 329 ; Fl. Br. Ind., V, 541 ; Beddome, Pl. 308.

MAR.—*Pat-phanas* ; TEL.—*Pejata* ; TAM.—*Anjili* ; KAN.—*Hebbhalasu* ; MAL.—*Aini*. TRADE—Aini.

A tall evergreen tree, generally 70–80′ in height and up to 15′ in girth, with a straight clean bole and dense foliage. It is common in the Western Ghats from North Kanara to Malabar, Coorg and Travancore.

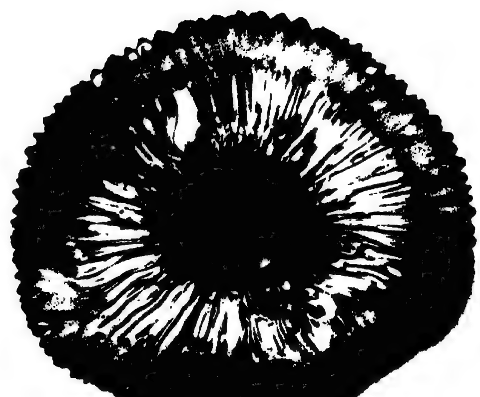
1. (a) A BUNCH OF ARECA NUTS
ARECA CATECHU

1. (b)
A WHOLE NUT

1. (c)
A SHELLED NUT

2. BREAD FRUIT
ARTOCARPUS COMMUNIS

3. JACK TREE
(ARTOCARPUS INTEGRA)



4. CROSS-SECTION OF JACK FRUIT

The tree requires heavy rainfall, not less than 70″ and thrives well in any soil, both at the foot of the ghats and on the slopes. For plantation purposes, fresh seeds should be sown in groups of five, spaced 6′×6′. It is more successfully grown as underwood in teak plantations. In the beginning, growth is somewhat slow, but once it is established, the tree grows rapidly (Troup, III, 878).

The wood is golden-yellow when fresh, but rapidly darkens on exposure, changing finally to walnut brown or blackish-brown. Its sp. gr. is approx. 0·52 ; and air-dry wt., 37 lb. per c. ft. Weight for weight, it is almost as strong as teak and has the advantage of lightness. It is straight or interlocked-grained, very coarse, and even-textured. Anatomically, it is similar to *A. chaplasha* but with larger vessels, narrower aureoles of paratracheal zonate parenchyma and narrower lower layer (Pearson and Brown, *loc. cit.*, 934).

It saws and works easily, takes good polish and finishes to a smooth surface. It is a very durable timber, even under water, and is not attacked by fungus or white-ants. It is difficult to treat, but treatment is not necessary. The timber seasons well without any serious defects, but it should be converted green to reduce surface cracking and splitting. Kiln seasoning improves its colour. The calorific value of heartwood (ash and moisture free) is 5233 cals. or 9499 B. Th. U., and its ash content 1·5% (Krishna and Ramaswami, *Indian For. Bull., New Series*, No. 79, 1932, 11).

On the West Coast, it is used for all purposes for which teak is employed : boat and ship-building (hulls, masts, decks and spars), constructional work (beams, rafters, door and window frames), furniture, cooperage, and for agricultural implements. It can be used for tea boxes (Limaye & Mohammed, *Indian For. Rec., New Series, Util.*, 1942, **2**, 186), and is also suitable for aircraft work.

The supply of *aini* is always insufficient to meet the demand. In 1937 prices fluctuated between Rs. 28–50 per ton in Madras, and Rs. 40–50 per ton in Bombay, in log form (Trotter, *loc. cit.*, 54).

The seeds contain 16·17% of oil : sp. gr., 30°/30°, 0·92 n_D ", 1·4762 ; acid val., 4·0 ; sap. val., 179 ; iod. val., 85·05. (Varier, *J. Indian chem. Soc.*, 1945, **22**, 275). It is used locally in medicine and is edible.

The latex has been found to contain : water and water soluble constituents, 59·6–70·6 ; and caoutchouc, 2·1–2·7% and the coagulum : caoutchouc, 6·6–7·1 ; resins, 87·0–91·4, and insolubles, 2·0–5·9% (Griffith and Budhiraja, *Indian For.*, 1943, **69**, 305).

A. integra (Thunb.) Merril = *A. heterophyllus* Lam. Syn. *A. integrifolia* Linn. f. JACK TREE
D. E. P., I, 330 ; C. P., 94 ; Fl. Br. Ind., V, 541 ; Pl. XIX, 394.

SANS. & TEL.—*Panasa* ; HIND.—*Kathal* ; BENG.—*Kanthal* ; MAR.—*Phanas* ; TAM.—*Pilapalam* ; KAN.—*Halasu* ; MAL.—*Chakka*.

A large tropical fruit-tree, with a dense crown reaching a height of 50′ or more. The straight, cylindrical stem is covered with rough bark which exudes milky latex. The plant is indigenous to India, probably the Western Ghats, where it grows wild. It is grown plentifully throughout the warmer parts of the country, especially in Bengal, Bihar and the Deccan. It is also grown in Ceylon, Burma, Malaya and Brazil and has been introduced into many other tropical countries.

For successful cultivation, it requires a moist tropical climate and a deep rich soil. Owing to its long delicate tap-root, seedlings cannot be easily transplanted. Seeds are, therefore, sown *in situ* during the rainy season. A spacing of 30–40′ is recommended. The tree is a good shade-bearer, but thrives best in the open. It is drought-sensitive and frost-tender (Troup, *loc. cit.*, 878).

In northern India, the jack tree is grown in orchards or around dwelling houses in villages, but no extensive cultivation is undertaken. However, systematic attempts at planting it have been made in Travancore and in the Intermediate Zone in Ceylon (McNeill, *Indian For.*, 1937, **63**, 380). Rich forest lands in semi-humid regions with periodic rainfall, uneroded soil high in silica and aluminium, and well-drained situations are necessary for its growth. *Artocarpus* plantations can be profitably combined with the cultivation of minor crops or catch-crops (McNeill, *loc. cit.*).

In southern India, the tree bears fruit in about eight years, while in northern India it takes much longer. The fruits are borne on the trunk and on the main branches. They are oval or oblong, 1–2′ in length and 6–12″ in diameter, and sometimes weigh as much as 60 lb. The skin, which is studded with short spikes, is pale green when immature, becoming greenish-yellow to brownish, when ripe.

The fruit contains a large number of seeds, each enclosed in a yellowish juicy sheath, with strong flavour. There are two common varieties : *Kapa* and *Barka* ; the former has a sweet, fleshy and crisp pericarp, and the latter, which is considered inferior, has a thin mucilaginous and sour pericarp. Several variations occur within these two types.

Unripe jack fruit is used as a vegetable or made into pickles, while the ripe one is eaten fresh or preserved in syrup. The fruit contains : moisture, 77·2 ; protein, 1·9 ; fat, 0·1 ; carbohydrates, 18·9 ; fibre, 1·1 ; mineral matter, 0·8 ; Ca, 0·02 ; P, 0·03% ; Fe, 0·5 mg. ; vitamin A, 540 I. U. ; vitamin C, 10 mg./100 g. (*Hlth. Bull.*, No. 23, 1941, 38 ; *vide* also Wehmer, I, 245). The seeds which form about 5·1% of the fruit are rich in starch and are eaten after roasting or boiling. They contain : moisture, 51·6 ; protein, 6·6 ; fat, 0·4 ; carbohydrates, 38·4 ; fibre, 1·5 ; mineral matter, 1·5 ; Ca, 0·05 ; P, 0·13% ; Fe, 1·2 mg./100 g. (*Hlth. Bull.*, *loc. cit.*, 33). According to Biswas (*Sci. & Cult.*, 1937, **3**, 56) they are also a good source of vitamins B_1 and B_2.

The wood is yellow when freshly cut, but gradually turns light brown on exposure. It is of medium weight (36 lb. per c. ft.), fairly strong (75–80% of the strength of teak), durable, and not attacked by fungi or white-ants. The calorific value of moisture-free heartwood is 5,369 cals. or 9665 B. Th. U. and its ash content is 2·4% (Krishna and Ramaswamy, *loc. cit.*). The timber seasons without trouble or degrade and kiln-seasoning offers no difficulty. It is easy to work and takes a good polish. The wood is cheap and of excellent quality, suitable for general carpentry work and plain furniture, for brush backs, inlay work and turnery (Trotter, *loc. cit.*). It is also a favourite wood for musical instruments. The timber has a local demand, but the tree being mainly grown for the fruit, is not available in commercial quantities, except perhaps in Bombay and Madras.

It is reported that an extract of the heartwood with alum is used by Buddhist priests for dyeing their robes yellow. Watson (*Mem. Asiat. Soc., Bengal*, 1907–10, **2**, 158) found that the *Artocarpus* dye was moderately fast on silk. The wood yields the yellow colouring matter, morin, and cyanomaclurin (Wehmer, I, 245). Tannin is present in small quantities (3·3%) in the bark (Burkill, I, 255).

The bark and the fruits exude a milky latex, (moisture and water solubles, 65·9–76·0 ; caoutchouc, 2·3–2·9%). The coagulum contains : caoutchouc, 6·0–10·0 ; resins, 82·6–86·4 ; and insolubles, 3·9–8·1% (Griffith and Budhiraja, *loc. cit.*). The latex is not of any value as a source of rubber, but the resin may be useful as a varnishing material (*Bull. imp. Inst., Lond.*, 1940, **38**, 296). It is said to be employed as bird-lime. A crystalline steroketone, artostenone, $C_{30}H_{50}O$, m. p., 109°, has been isolated from the dried latex (Nath, *Sci. & Cult.*, 1935-36, **1**, 434 ; *ib.*, 1937-38, **3**, 57). This has been converted to artosterone, a compound with highly androgenic properties (Nath & Sen Gupta, *Indian J. med. Res.*, 1939, **27**, 171).

A. lakoocha Roxb. MONKEY JACK

D. E. P., I, 333 ; Fl. Br. Ind., V, 543.

HIND.—*Barhal* ; BENG.—*Dephal* ; MAR.—*Wotomba* ; TEL.—*Kamma-regu* ; KAN.—*Vatehuli* ; BURM.—*Myankdok.* TRADE—Lakuch.

A deciduous tree with a clear straight stem, generally 20–30′ high and up to 8′ in girth. It occurs in the sub-Himalayan tract (up to 4,000′) from Kumaon eastwards to Assam, and southwards to Burma and the Andamans. It is met with in Bihar, Orissa and the Central Provinces. In the West Coast it is found from Konkan southwards to Malabar and Travancore.

The tree is also cultivated for its edible fruits. These are roundish (2–4″ diam.), ill-shaped, and of a dirty yellow colour and sweetish sour taste. A full grown tree yields 7–11 cwt. of fruits per annum.

The wood is yellowish-brown when fresh, but turns dark-brown after exposure. According to Trotter (*loc. cit.*, 54) it is heavier than other *Artocarpus* woods (40 lb. per c. ft.). It is fairly strong, similar to teak in transverse strength and modulus of elasticity. It is straight or interlocked-grained, very coarse and even-textured. Anatomically, it is similar to *chaplash* but has more numerous vessels, metatracheal diffused parenchyma, smaller fibres and narrower rays.

Lakuch is durable both in exposed situations and under water, and is not liable to attack by fungi or white-ants. It saws and works well, finishing to a fine smooth surface, but does not take a satisfactory polish. The wood seasons easily, but logs should be converted soon after felling. The

timber is much used for constructional work (posts, beams, rafters and scantlings), medium weight furniture and for boat-building. It is available only in limited quantities as the trees are not common in forests (Pearson and Brown, *loc. cit.*).

The latex contains : water and water solubles, 68·8, and caoutchouc, 3·7% ; and the coagulum : caoutchouc, 12·2 ; resins, 32·8 ; and insolubles, 5% (Griffiths and Budhiraja, *loc. cit.*). The bark contains 8·5% of tannin (Hooper, ex Burkill, *loc. cit.*, 275). In Assam, it is chewed as a substitute for betel-nuts. The roots of this species are richer in colouring matter than those of the other *Artocarpus* spp.

ARUM Linn. — ARACEAE

D. E. P., I, 333 ; Fl. Br. Ind., VI, 509.

Many plants formerly referred to this genus are now transferred to other genera such as *Alocasia*, *Amorphophallus*, *Arisaema*, *Colocasia*, *Typhonium*, etc. The genus now comprises 12 species of herbs, found in Europe, the Mediterranean region, and West Africa, and extends from Afghanistan to India. *A. jacquemontii* Blume is the only species which occurs in India (Kashmir).

The starch from the tubers of *A. maculatum* Linn. (Britain) was formerly used as food (Portland arrowroot), but it is difficult to remove the poisonous juice associated with it (Willis, 57). Its leaves and tubers have been found to contain 1% of a glucosidic saponin (Wehmer, I, 134).

ARUNDINARIA Michx. — GRAMINEAE

D. E. P., I, 335 ; C. P., 99 ; Fl. Br. Ind., VII, 376 ; Gamble, *Ann. R. bot. Gdn Calcutta*, 1896, **7**, 1.

This genus of bamboos includes nearly 80 species distributed in the tropics of Asia, Africa and America. About 26 species occur in India. Excepting *A. praini* Gamble (*Thamnocalamus prainii* E.G. Camus) which is a climber, most of them are erect shrubs, bearing long, slender (up to 30′ in length, and 0·3–0·8″ in diameter), mostly greenish culms. Flowering, as in other bamboos, is gregarious and takes place at long intervals. But *A. wightiana* Nees flowers annually.

A. falcata Nees is found from Ravi to Nepal in western Himalayas at 4,000–7,000′ and also in Sikkim. *A. intermedia* Munro [=*Chimonobambusa intermedia* (Munro) Nakai] also grows in the Sikkim, Himalayas, and *A. racemosa* Munro in Nepal and Bhutan up to 6,000–12,000′. *A. spathiflora* Trin. [=*Thamnocalamus spathiflorus* (Trin) Munro] is found as a thick undergrowth in fir, oak and deodar forests in western Himalayas between 7,000–9,000′. *A. jaunsarensis* Gamble grows in the hills of Jaunsar in Garhwal at about 7,000–8,000′. *A. khasiana* Munro [=*Chimonobambusa khasiansa* (Munro) Nakai] is common in the Khasi Hills at higher altitudes (5,000–6,000′), and *A. suberecta* Munro at lower altitudes (4,000′). *A. hirsuta* Munro forms large stretches beyond Japvo in the Naga Hills at 9,700′. *A. mannii* Gamble is a slender, tufted, climbing wiry bamboo of the Jaintia Hills (3,000′). *A. debilis* Thw. grows in Ceylon at 6,000–8,000′.

Of the south Indian species *A. densifolia* is a shrub growing at high altitudes in Anamalai Hills (8,500′), and *A. wightiana* is an invariable member of the evergreen forests of Travancore, Malabar, Shevaroy Hills and North Canara.

The split culms of most of these bamboos (*A. spathiflora*, *A. jaunsarensis*, *A. racemosa*, *A. wightiana*, etc.) are locally employed for cottages and for making mats and baskets. Some species like *A. debilis* and *A. racemosa* are used as fodder for cattle and ponies, especially during the rainy season. A few other species, such as *A. falcata* and *A. intermedia*, being thin and slender, make elegant fishing rods, and tubes for hookahs.

ARUNDO Linn. — GRAMINEAE

A genus of tall stout reed-grasses, comprising about 12 species, distributed over the tropical and temperate regions of the world. Three species occur in India.

A. donax Linn. — GREAT REED, SPANISH CANE

D. E. P., I, 336 ; Fl. Br. Ind., VII, 302.

HIND. *Bara nal* ; PUNJAB—*Bansi* ; BENG.—*Gaha nal* ; BURMA—*Alo-kyu*.

A perennial reed grass, usually 6–12′ high, found in the lower Himalayas from Kashmir to Nepal and Assam, ascending up to 8,000′. It is also met with in the Nilgiris, Coorg and Burma, and is distributed westwards to north Asia and Africa, and Europe.

This reed is used in southern Europe for the manufacture of baskets, mats, trays, fishing rods, etc., and for making musical pipes. When the reeds

are made fire-proof by treatment with water-glass, etc., they can be used for thatching (*Chem. Abstr.*, 1936, **30**, 5692).

The stalks and leaves of cultivated reeds yield a pulp of high α-cellulose content (*Bull. imp. Inst., Lond.*, 1944, **42**, 246). In Italy this pulp is used for rayon manufacture (*Chem. Abstr.*, 1940, **34**, 619). It may also be used for making explosives (*Chem. Abstr.*, 1938, **32**, 6861).

Raitt (*Indian For. Rec.*, 1913, **5**, 90) considers *A. donax* to be one of the most suitable raw materials in India for the manufacture of high grade writing paper. He has found it to contain: total cellulose, 42·8; and lignin, 9·4%, and to yield 37% of unbleached pulp, and 34% of bleached pulp. Reed of Chinese origin has been found to contain: total cellulose, 50·3 (α-cellulose, 36·2); and lignin, 15·7%, and to yield 44% of bleached pulp (*Chem. Abstr.*, 1942, **36**, 2717).

Two alkaloids, gramine (donaxine) $C_{11}H_{14}N_2$, m.p., 138–139°, donaxarine $C_{15}H_{16}O_2N_2$, m.p., 217°, have been isolated from *A. donax*. The former in small doses raises blood pressure in dogs, but in larger doses it causes a fall. Its action is similar to that of *d*-pseudo ephedrine (Henry, 448).

Asafoetida, see **Ferula assafoetida**

ASBESTOS

D. E. P., I, 338; C. P., 94; Pl. XX, 2 4.

HIND.—*Sangaresha*; MAR.—*Shankhapalita*; TEL.—*Ratinara*; TAM. & KAN.—*Kalnar*.

Commercial asbestos includes several minerals, which can be easily split into flexible fibres, capable of being felted or spun together. These are divided into two groups: chrysotile or serpentine asbestos, $3MgO. 2SiO_2. 2H_2O$, and amphibole asbestos. The latter includes: (*a*) fibrous varieties of tremolite, $CaO. 3MgO. 4SiO_2$, and actinolite, $CaO. 3(Mg, Fe)O. 4SiO_2$, (*b*) anthophyllite, $(Mg, Fe)O. SiO_2$ and amosite, which is richer in iron than anthophyllite and (*c*) crocidolite or blue asbestos, $NaFe (SiO_3)_2. FeSiO_3$. The qualities which make asbestos technically valuable are its fibrous structure, infusibility, high heat and electrical resistance, and insolubility in acids. The length of fibres and their tensile strength are important in asbestos meant for spinning.

Chrysotile asbestos occurs in small narrow veins, mostly as 'cross-fibre' (fibres arranged perpendicularly to the walls of the veins), usually ¼–1″ wide, in massive serpentine. These veins consist of white or green (sometimes yellowish or reddish) aggregates of fine crystalline silky fibres; but the colour of individual fibres, when they are pulled apart, is white. Fibres of good chrysotile are characterised by their extreme fineness or silkiness, high tensile strength and flexibility. They can be readily spun into yarn and woven into cloth. Chrysotile can withstand high temperatures, but not to the same degree as amphibole varieties (excepting crocidolite). Unlike other asbestos minerals it is decomposed by hydrochloric acid.

Tremolite-actinolite asbestos is associated with tremolite and actinolite-schists and amphibolites. Usually it occurs in veins as 'slip-fibre' (fibres arranged parallel to the walls of the veins), forming long columnar masses or 'logs'. The fibres are generally very long, but they are often weak and brittle and are not suited to spinning. This asbestos has good insulating and acid-resisting properties, and its quality usually improves with depth of working. The mode of occurrence of anthophyllite is similar to that of the tremolite-actinolite species. This asbestos occurs largely as 'mass-fibre' (unoriented or confused bundles of fibres, sometimes radially arranged). Its fibres are also brittle and are valueless for spinning.

Amosite and crocidolite do not occur in India.

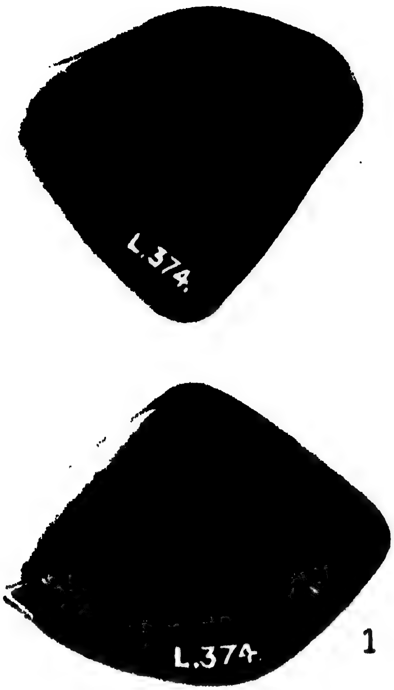
DISTRIBUTION

The following are the important occurrences of asbestos in India (*Mem. geol. Surv. India*, 1934, **64**, 143):

Bihar: According to Dunn (*Mem. geol. Surv. India*, 1942, **78**, 78) in the Dhalbhum division of Singhbhum dist., asbestos deposits have been prospected at Lipokocha (22° 25′ : 86° 30′), Maheshpur (22° 23′ : 86° 30′), Chirutanri (22° 24′ : 86° 34′), Digarsai (22° 35′ : 86° 15′), and Manpur (22° 36′: 86° 16′). Most of these deposits were found to be tremolite asbestos. Manpur asbestos is brittle, but its quality improves with depth. Sometimes it contains a small proportion of flexible material.

Bombay: Amphibole asbestos occurs associated with steatite near Dev Mori (23° 41′ : 73° 24′) in Idar State. This asbestos is remarkably pure, soft and silky, and consists of long and flexible fibres. It can be dug up in sticks of about a foot long, which yield very soft fibre of low tensile strength. It

Pl. XX



1

1. BURMESE AMBER (Burmite

2. ASBESTOS FROM SERAIKELA

3. A BLOCK OF ASBESTOS

4. VEINS OF ASBESTOS

can be used for insulation, and in the manufacture of asbestos cement, etc.

Central India : Asbestos of inferior quality suitable for fire-proof packing, occurs in Jobat State.

Central Provinces : In Bhandara dist., asbestos occurs with talc. Between 1908 and 1924 there was a total output of about 84 tons of crude asbestos from Tumkhera Khurd (21° 25′ : 80° 13′). Production since 1925 has not been recorded.

Eastern States : In Seraikela State, asbestos occurs at Bara Bana (22° 38′: 85° 55′), Surangposi (22° 39′: 85° 59′), Rajnagar, Patakocha, etc. Of these, Bara Bana deposit is the most important. Here tremolitic asbestos occurs in logs up to 14′ in length and 12″ in diameter. The mineral is too brittle for spinning, but it has been found useful for lagging. Chrysotile asbestos is found in Rajnagar.

Madras : In Cudappah dist. chrysotile asbestos occurs as thin veins or seams associated with the serpentinised magnesian limestone, in Pulivendla taluk, near Brahmanapalle, Ippatla, Chinnakudala, Lingala, Lopatanutula and Vempalle. Most of the veins have a thickness of 0·1–1·5″, the average being about 0·5″. In the Lakshmana mine near Chinnakudala, some veins were found to contain fibres up to nearly 7″ in length. The distribution of asbestos in different parts of this belt is very irregular. Detailed work near Brahmanapalle and Chinnakudala showed that a three mile length of asbestos zone may be workable, and that the average thickness of veins is about 5″. It is estimated that about 250,000 tons of asbestos are present within a distance of 250′ along the dip of the dolomite which is 18–20° NNE. (Krishnan). In Kamalapuram taluk, near Rajupalem, the veins are usually about ¼″ (occasionally ½″), in thickness.

Cudappah dist., which used to contribute some asbestos, produced only about 8 tons in 1934 and 1935.

In Kurnool dist. thin veins of chrysotile asbestos (not more than 3/16″ in thickness) occur in serpentinised lime-stones near Malkapuram (15° 21′: 77° 59′) in Dhone taluk, and near Joharapuram (15° 49′ : 78° 4′) in Kurnool taluk.

Mysore : Thin veins of asbestos occur in several places in Mysore State. The most important of these are near Holenarsipur (Hassan dist.). Two of these deposits contain large veins of amphibole asbestos (anthophyllite and tremolite), and they are estimated to yield 20 25 thousand tons up to a depth of 100′. Asbestos here occurs in veins of various dimensions, forming massive sheets or logs running parallel to the walls of the veins, or as much smaller puckered bundles of cross-fibre. Much of this, when crushed, breaks up into short brittle fibres, unsuitable for spinning. Attempts are being made to use it for making cement-asbestos sheets and pipes (Rama Rao, *Quart. J. geol. Soc. India*, 1942, **14**, 174).

It is reported that, in 1929-30, the Mysore Asbestos Mill Ltd. exported 205 tons of asbestos to Belgium and England.

Rajputana : Asbestos veins (up to ¼″ in width) traverse a serpentine band in limestone near Kanwalai (Kaolai, 26° 36′ : 74° 35′) NNW. of Ajmer city. They have been worked in a large open cut. About 6 tons of asbestos were produced from Ajmer-Merwara in 1927 and in 1931. Production was again reported in 1937 and 1938 (3 tons).

United Provinces : In Garhwal dist., asbestos occurs in the hills north of Ukhimath (30° 32′ : 79° 6′). It is of good quality and may be used for fire-proof packing and packing for steam-joints. Veins of asbestos near Joshimath are sometimes 4–5″ wide, and masses of asbestos more than 6′ in width, occur in rock of serpentine nature.

MINING AND DRESSING

Prospecting for asbestos is confined to the narrow range of rocks, with which it is commonly associated. These are basic and ultra-basic igneous rocks, their metamorphic derivatives containing serpentine or amphiboles, and metamorphosed magnesian limestones. Asbestos deposits often occur under an over-burden, usually of soil or boulder clay. The outcrop is uncovered by trenching or stripping. Most of the deposits are developed by test pits, which are enlarged into quarries, when results are promising. Sometimes exploratory work has to be carried out by tunnelling, or by diamond or calyx drilling. In Canada, asbestos veins have been proved to extend to a depth of 1,700′ without any change in the quality of the mineral. Rich deposits of asbestos can be worked by open-pit working up to a depth of 500–600′. Beyond this underground mining methods, like those used in metal mining, have to be adopted.

The ore is usually soft or of medium hardness. In India, extraction is carried out by hand drilling, explosives, cold chisels, and hammers. In other countries, air drills are used. Wet drilling is not advisable, since asbestos fibres form a spongy mass with water, difficult to clear. The broken rock is conveyed to the surface, where it is prepared for the market. In many mines, preliminary dressing for the recovery of long fibres is carried out by manual labour. Canadian mines are highly mechanised, and methods of cobbing, milling and grading are described by Ross and Jenkins (Amer. Inst. Min. Metall. Engrs., Industrial Minerals and Rocks, 1937, 75).

According to Coggin Brown (*Bull. Indian Industr. Lab.*, 1922, **20**, 1) good asbestos, if rubbed between fingers, yields a fine silky thread of high elasticity, whereas asbestos of poor quality splits into harsh and somewhat brittle fibres ; if a thin bundle of fibres is drawn slowly over the thumb-nail while bending it sharply, with a steady pull, fibres of high flexibility and tensile strength remain unaffected or split into finer fibres, whereas those of inferior asbestos snap ; and good asbestos fibres roll into a soft feathery ball, whereas bad asbestos fibres break. These characteristics may be employed as field tests for judging the quality of asbestos.

USES AND TRADE

Asbestos is marketed in different grades : shingle stock, paper stock, cement stock and shorts. It is used for insulation of all kinds, for the manufacture of non-conducting materials, for the filtration of acids, and for packings, for every type of steam and water valve stems. The longer fibres are spun into single-ply and multi-ply yarns which are woven into fabrics, ropes and tapes. Asbestos cloth is employed in the manufacture of a large number of asbestos goods such as fire-proof curtains, shields and clothing. Glazed asbestos yarn enters into the composition of incandescent mantles. Asbestos webbing is utilised for wrapping electric cables and for the insulation of steam pipes and hot surfaces. Woven with fine metallic wire, asbestos is used for brake linings. Blue asbestos, owing to its resistance to acids, is invaluable in chemical, and explosives factories and dye-works.

The shorts have also various uses. They are compressed with a binding material into paper or board for insulation. Asbestos paper is produced from a mixture of asbestos, starch, kaolin and sodium silicate. Asbestos boards are largely used for panels, ceilings and partitions. Mill-boards form the foundation of most packing and jointing materials. Compressed fibre jointing, made by impregnating special grades of the mineral with suitable cementing solutions and rolling them into sheets under high pressure, is in considerable demand.

The short and brittle varieties of asbestos can be used in the manufacture of shingles, asbestos-magnesia insulation, asbestos paints and various asbestos moulded articles. Asbestos-magnesia insulation is made from a mixture of 85% of powdered magnesium carbonate and 15% of asbestos. Asbestos paint consists of a mixture of asbestos and asphalt and is used in structures exposed to acid fumes. A mixture of asbestos fibres, Gilsonite cement and oil, is moulded under pressure into a variety of articles. After baking, some of them are used as electrical fittings.

In India, the largest use of asbestos is for the production of asbestos-cement products such as slates, tiles, sheets, pipes, etc. Indian asbestos belongs mainly to the tremolite and actinolite species of amphibole asbestos. Its fibres are too weak and brittle for spinning, and it can be used mainly for insulating purposes. Serpentine asbestos, on the other hand, is of far greater importance, and forms the raw material for the manufacture of the major portion of asbestos goods. Manufacturers of asbestos products in India are making increasing use of asbestos, imported chiefly from Canada, South Africa, Cyprus and Portuguese East Africa.

Indian production of asbestos is small, and in recent years the major portion of asbestos mined in India has come from Seraikela State (Eastern States). Expansion in production is dependent on the development of suitable uses for Indian asbestos.

INDIAN PRODUCTION

	Seraikela State Cwt.	Total Production Cwt.	Val. Rs.
In quinquennium ending—			
'28	1,280	1,696	13,888
'33	680	1,790	5,284
'38	1,198	1,336	4,464
'43	3,114	9,283	70,959
In '44	2,680	11,660	1,21,805
„ '45	2,720	...	...

AVERAGE ANNUAL IMPORTS OF ASBESTOS (RAW AND MANUFACTURED) INTO BRITISH INDIA

	Raw asbestos		Manufactured asbestos	Total
	Qty. (Cwt.)	Val. (Rs.)	Val. (Rs.)	Val. (Rs.)
In quinquennium ending—				
'33-34 .	1,439	16,715	24,83,940	25,00,655
'38-39 .	37,679	3,41,715	15,68,421	19,10,136
'43-44 .	1,43,463	25,70,779	18,35,955	44,06,734
In '44-45 .	2,11,110	43,66,750	19,84,086	63,50,836
„ '45-46 .	97,896	26,75,774	25,16,610	51,92,384

Over 80% of imports of asbestos are from the U.K. Imports of asbestos-cement products (q.v.) are very small owing to indigenous manufacture.

AVERAGE ANNUAL EXPORTS OF MANUFACTURED ASBESTOS FROM THE U. K. TO INDIA*

	Packing, lagging and jointing (Cwt.)	Yarn & cloth (Cwt.)	Other manufactures (Cwt.)
In quinquennium ending—			
'39	9,372	n.a.	6,686
'44	13, 951	1,289	14,713

* *Tr. U. K.*, III.

ASCLEPIAS Linn. ASCLEPIADACEAE

A large genus, consisting of nearly 160 species of herbaceous plants. It is mostly American with few African and West Indian representatives. *A. curassavica* has been introduced into India from the U. S. A. and has become naturalised.

The follicles of *Asclepias* contain masses of soft fine floss resembling kapok but on account of their inferior resilience and straightness they are not of much value.

The stem yields a fibre, but it is difficult to obtain long strands, although it is comparatively easy to separate it into its ultimate filaments. Advantage can be taken of this property in the textile industry for spinning the fibres with cotton (*Bull. imp. Inst., Lond.*, 1931, **29**, 441).

Several species of *Asclepias* yield latex. The rubber is localised in the tissues of leaves (2%) and of ovules (10%), of *A. cornuti* Decne. (=*A. syriaca* Linn.). It is not of a good quality owing to its high resin content (*Mon. Bull. Agric. Sci., Rome*, 1937, **28**, 469T).

A. curassavica Linn. CURASSAVIAN SWALLOW-WORT, WEST INDIAN IPECACUANHA

D. E. P., I, 343 ; Fl. Br. Ind., IV, 18 ; Kirt. & Basu, Pl. 622B.

HIND.—*Kakatundi* ; MARH.—*Kurki*.

A perennial, erect herb with oleander-like leaves and beautiful orange-red flowers.

The seed hairs of *A. curassavica* are stronger than those of any other species of *Asclepias*. The fine bast fibre may be used in textiles in combination with cotton (*Bull. imp. Inst., Lond., loc. cit.*).

The plant is said to contain a poisonous glucoside called Asclepiadin (Burkill, I, 261).

The juice of leaves is said to be anthelmintic and sudorific ; that of the flowers, styptic. The root is called West Indian or Bastard Ipecacuanha on account of its emetic properties.

Ash, Common—see **Fraxinus excelsior.**

Asoka tree, see **Saraca indica**

ASPARAGUS Linn. LILIACEAE

A large genus of herbs or undershrubs with stout, creeping, tuberous root-stocks, and erect or climbing stems. The leaves are reduced to spinescent structures and their function is carried on by slender flattened green branch structures, called cladophylls. It includes about 150 species distributed throughout the old world, of which nearly 17 are found in India.

Many species are regarded as diuretic and demulcent. *A. filicinus* Buch.-Ham. is considered astringent and tonic, and *A. gonocladus* Baker, useful in skin complaints. A few, like *A. plumosus* Baker are ornamental.

A. adscendens Roxb.

D. E. P., I, 343 ; Fl. Br. Ind., VI, 317.

ARAB. & PERS.— *Shaqaqule-hindi* ; HIND. & MAR.— *Satavar, safed-musli* ; GUJ.—*Ujli-musli, dholimusali*.

An excessively branching, sub-erect tall plant, with densely crowded whitish cladophylls, found in Afghanistan, the Punjab, and in the Himalayas up to an altitude of 5,300′.

It is sometimes used as a vegetable. The white tubers are hairy and mucilaginous and swell up with water. They are reported to possess cooling and demulcent properties. Their uses are similar to those of 'Salep *misri*' (*Orchis mascula* Linn.).

A. officinalis Linn. ASPARAGUS

D. E. P., I, 344 ; Parker, 521.

ARAB.—*Halgun, asbara-ghus* ; PERS.—*Halgun, margiyah* ; HIND.—*Nag-down, halyun* ; BENG.—*Hillua*.

A perennial plant with an erect branching stem, nearly 4–6′ in length. It is indigenous to temperate Europe and Asia, whence it has been introduced into many other parts of the world. In America, it is an important commercial crop.

Asparagus thrives best in well-drained, deep, loose soil. It requires a liberal use of fertilizers. The seeds are soaked in warm water for a day before sowing and vigorous seedlings, when a year old, are transplanted.

The only serious fungal pest is rust caused by *Puccinia asparagi* DC. which can be controlled by spraying with Bordeaux mixture. The use of rust resistant varieties, have been suggested.

The common asparagus beetle (*Crioceris asparagi* Linn.), and the 12-spotted asparagus beetle (*C. duodecimpunctata* Linn.) cause extensive loss by feeding on the crop. Starving the insects by cutting the plants in spring, and allowing poultry to feed on them are considered helpful. But spraying with arsenicals is the most effective method of control.

Once started, asparagus will continue to yield for well over 15 years. The new succulent shoots which come up every year constitute the asparagus of commerce and large quantities are canned. They are also eaten green. Asparagus is rich in vitamins and is nutritious. It contains: moisture, 93 ; protein, 2·2 ; fat, 0·2 ; carbohydrates, 3·2 ; fibre, 0·7; ash, 0·7; Ca, 0·025; P, 0·039% ; Fe, 0·96 mg.; Cu, 0·14mg.; vitamins—A, 1400 I.U.; B_1, 180 g. ; B_2, 130 g. ; C, 40 mg./100 g. (Heinz Co., Nutrit. Charts, 1942, 21).

A white crystalline substance, asparagine, $C_4H_8O_3N_2 \cdot H_2O$ is obtained from the juice of young shoots. It is considered to be a good diuretic and is used especially in cardiac dropsy and chronic gout.

A. racemosus Willd.

D. E. P., I, 34 ; Fl. Br. Ind., IV, 316.

SANS. & BENG.—*Satamuli* ; HIND.—*Satawar* ; MAR.—*Satawarmul* ; GUJ.—*Satawari* ; TEL.—*Challagadda, pilli-tegalu* ; TAM.—*Shimai-shadavari* ; KAN.—*Majjige-gadde* ; MAL.—*Shatavali*.

A scandent climber, distributed throughout tropical Asia, Africa and Australia. It is common in India, ascending up to an altitude of 4,000′ in the Himalayas, and in Ceylon.

Several medicinal properties are attributed to the root. It is said to be tonic and diuretic and useful as a galactagogue. A mixture of honey and fresh root juice is given as a demulcent in dyspepsia. However, Koman (1920, 12) states that the action of the drug when administered in dyspepsia was slow and not highly satisfactory. The root is largely used in the preparation of medicated oils, prescribed for nervous and rheumatic complaints (Dymock Warden & Hooper, III, 483).

A. sarmentosus Linn.

D. E. P., I, 346 ; Fl. Br. Ind., VI, 319.

Indian names are the same as those of the preceding species.

A climber found throughout India. The roots are considered nourishing and aphrodisiac, and are said to be used to adulterate those of *Aconitum heterophyllum*.(q.v.)

Asphalt, see **Bitumen**

ASPHODELUS Linn. LILIACEAE

D. E. P., I, 346 ; Fl. Br. Ind., VI, 332.

A genus of annual or perennial herbs, including about 12 species, distributed in the Mediterranean region and extending eastwards to India. *A. fistulosus* Linn., and *A. tenuifolius* Cav. are found as weeds in the Indo-Gangetic plain, from Bengal to the Punjab. The former is eaten during famines. The seeds of both species are considered to be diuretic.

ASPLENIUM Linn. POLYPODIACEAE

D. E. P., I,347.

A large genus of cosmopolitan ferns of various habits, comprising about 540 species.

Some of the common species found in India, and occasionally grown as ornamental ferns are: *A falcatum* Lam., *A. lunulatum* Sw., and *A. laciniatum* G. Don (Blatter & d'Almeida, 103).

A few are regarded as medicinal, e.g. *A. adiantum-nigrum* Linn., *A. ruta-muraria* Linn., *A. trichomanes* Linn., *A. falcatum* Lam. (Caius, *J. Bombay nat. Hist. Soc.*, 1935, **38**, 349; *vide* also Chopra, 465, 455).

For *A. esculentum* Retz, see *Diplazium esculentum* Presl.

Assam rubber, see **Ficus elastica**

ASTER Linn. COMPOSITAE

Fl. Br. Ind., III, 249.

A large genus of 500 species of herbs or shrubs distributed in northern temperate regions. Many of them bear beautiful flowers and are cultivated in gardens. *A trinervius* Roxb.(= *A. amellus* Linn.) is found in the central and western Himalayas and Khasia Hills and extends to China and Japan. The Chinese use its roots for coughs and pulmonary affections, and also in the treatment of malaria and haemorrhage (Chopra, 465).

ASTERACANTHA Nees ACANTHACEAE

A genus comprising 2 species, of which *A. longifolia* is present in India.

A. longifolia Nees Syn. *Hygrophila spinosa* T. Anders.

D. E. P., IV, 316; Fl. Br. Ind., IV, 408; Pl. XVII, 3.

SANS.—*Kokilaksha*; HIND. & MAR.—*Talimakhana*; BENG.—*Kuliakhara*; TEL.—*Neerugubbi*; TAM.—*Nirmulli*.

A small spiny herb, 2–4′ high, found in moist places throughout India and Ceylon. With water its seeds develop a large amount of tenacious mucilage. The seeds contain 23 per cent. of a yellow, semidrying oil (sap. val., 196; iod. val., 126; linoleic acid, 71%—Godbole, Gunde, and Srivastava, *Oil & Soap*, 1941, **18**, 296). They also contain diastase, lipase and protease (Lagavankar, Phalinikar and Bhide, *J. Univ. Bombay, New Series*, 1945, **13**, V-A, 15).

The roots, leaves, and seeds are used in the Indian medicine as diuretics, and have also been employed for jaundice, dropsy, rheumatism, anasarca, and diseases of the urino-genital tract (Koman, 1919, 13; Kanny Lall Dey, 159). Chopra and Ghosh attribute the diuretic properties of the seeds to the large amount of mucilage, and the potassium salts in them (*Indian J. med. Res.*, 1934, **22**, 268). The ash of the seeds (6·4%) contains: K_2O, 3·3; P_2O_5, 2·1% (Lagavankar *et al.*, *loc. cit.*).

ASTRAGALUS Linn. LEGUMINOSAE

A large genus of herbs or undershrubs (often spinous) comprising about 1,600 species, distributed in the mountainous regions from Asia Minor through Kurdistan to Iraq, Persia and north-western India. A few of these species, especially *A. gummifer* Labill. are the source of the commercially important gum tragacanth.

Of tragacanth-yielding species in India, only *A. strobiliferus* has been reported to occur in upper Kurram and Chitral (Qazilbash, *Indian J. Pharm.*, 1941, **3**, 189).

About 70 species of *Astragalus* are reported to occur in India. *A. hamosus* Linn. (Baluchistan, Sind, and the plains of the Punjab), *A. multiceps* Wall. (western Himalayas, Garhwal and Kumaon), *A. tribuloides* Delile (plains of western and central Punjab) are medicinal, being used as emollients and demulcents.

Tragacanth is formed as a result of the transformation of the cells of pith and medullary rays into a mucilaginous substance. It is obtained on making incisions, usually at the base of the stem, and the oozing gum is allowed to dry before it is collected. It forms irregularly flattened flakes of lamellated and ribbon-like appearance, about 0·5–2·5 cm. long, 1 cm. broad, and 0·5–3 mm. thick. There are several commercial grades of tragacanth based on colour, thickness, etc. The best grades are used in pharmacy, and other grades in calico-printing and other industries.

Only a part of the gum is soluble in water and the rest swells to a highly viscous gel, absorbing a large quantity of water (about 50 times its own weight). The viscosity of the solution is very much higher than that of a solution of Karaya gum (*Sterculia urens* and other species) of the same concentration. Karaya gum is used as a substitute for tragacanth. Since it develops acidity, the latter is preferred in cosmetic preparations. On hydrolysis with phosphoric acid, tragacanth yields 2·5% of

acetic acid, whereas Karaya gum yields, 15·8% (*U.S. Dep. Agric., Bur. Chem., Cir.*, No. 94, 1912).

Tragacanth is mainly composed of bassorin (60–70%), tragacanthin (8–10%) and a little starch. Bassorin is a complex carbohydrate insoluble in water, with which it swells considerably; tragacanthin is soluble and is built up of uronic acid and arabinose units (Norman, *Biochem. J.*, 1931, **25**, 200). The ash content of tragacanth varies from 1·5–3%.

Tragacanth is an important commercial gum. In pharmacy, it is used as a demulcent and emulsifier, and as an adhesive agent for pills and tablets, and for the suspension of insoluble powders. It also finds application in confectionery and in cosmetic preparations. In the textile industry, it is chiefly used in dyeing and printing and as a sizing material. It is an ingredient of dressing and weighting compositions for leather.

The bulk of commercial tragacanth comes from Kurdistan, Iraq and Persia. The best grades preferred in pharmacy come from Smyrna, and other ports of the Persian Gulf, and are known as Persian or Syrian tragacanth.

A. strobiliferus Royle

Fl. Br. Ind., II, 135; *Indian J. Pharm.*, 1941, **30**, Ill., p. 191.

PER.—*Jib*; CHITRAL—*Garmezu*.

A much-branched undershrub mainly found in Persia, and occurring also in western Himalayas and upper Kurram. It is fairly common at Birmolast in Chitral at 5,500′ (Qazilbash, *loc. cit.*).

The plants occurring in Chitral have been found to yield tragacanth. The naturally exuding gum is of inferior quality, but the gum obtained by making incisions on the plant compares favourably with commercial tragacanth. The cultivation of this species in Chitral and other areas, where soil and climatic conditions are favourable, has been suggested.

ASYSTASIA Blume — ACANTHACEAE

Fl. Br. Ind., IV, 492.

This genus includes about 30 species of herbs with showy flowers, distributed in tropical Asia and Africa. Some of them like *A. africana* Hort. Bogor., ex T. Anders., *A. gangetica* (Linn.) T. Anders. (syn. *A. coromandeliana* Nees) and *A. travancorica* Bedd. are cultivated as ornamental plants. *A. gangetica* is a straggling herb with multi-coloured flowers, common in the Deccan, and Ceylon. In Travancore, the leaves are used as fodder. The juice of the plant is said to be administered to children for swellings and rheumatism (Rama Rao, 307).

ATALANTIA Correa — RUTACEAE

A genus of small evergreen trees or shrubs, comprising about 18 species, distributed in tropical Asia, China and Australia. Six species are found in India, of which *A. monophylla* is a timber tree of the third class.

A. missionis Oliver

D. E. P., I, 349; Fl. Br. Ind., I, 513.

SINGH.—*Pamburu*.

A small tree with sharp thorns and a green bushy head, distributed in south India and the hotter parts of Ceylon.

The wood is yellowish-white, moderately hard, and weighs 48 lb. per c. ft. It is used for furniture and cabinet-work (Gamble, 129).

A. monophylla Correa = *A. malabarica* (Rafin.) Tanaka — THE WILD LIME

D. E. P., I, 349; Fl. Br. Ind., I, 511.

SANS.—*Atavi-Jambira*; MAR.—*Makad-limbu*; TEL.—*Adavi-nimma*; TAM.—*Kattelumicchai*; KAN.—*Kadu-nimbe*; MAL.—*Kattunarenga*.

A small tree with smooth brown bark and thorny branches, distributed throughout the mountainous regions of south India, Assam and Ceylon, extending to the Andamans and Burma.

The wood, when first exposed, is pale yellow to yellowish-white, but gradually becomes light brownish-yellow. It is smooth, lustrous and heavy (sp. gr., 0·92; air-dry wt., 59 lb. per c. ft.). Usually it has a fine texture and is straight-grained.

Anatomically, the wood is characterised by very small vessels encircled by parenchyma and extensive tracts of short, fine, libriform fibres, containing yellow gummy deposits and starch grains.

It is a durable timber under cover and saws easily when green. It is difficult to season as it develops end-splits. This can be avoided by

sawing the logs to the centre on one side. It takes a high polish and is the best substitute for boxwood.

The timber is useful for cabinet-work and furniture. Since the wood is strong and shock-resistant, it is recommended for camp-furniture. It may be tried for making articles of turnery.

The berries yield an oil which is used externally in rheumatism.

ATHYRIUM Roth POLYPODIACEAE

A genus of ferns, comprising 120 cosmopolitan species. *A. filix-femina* Roth (Lady Fern) is found in the Himalayas from Sikkim to Garhwal, in Central India and on the Eastern Ghats. The rhizome is sometimes used as a substitute for that of *Dryopteris filix-mas* Linn. (Male Fern). It is supposed to be a vermifuge, but according to Trupp and Goodrich (*Chem. Abstr.*, 1940, **34**, 5492) it is unlikely to be of any value as an anthelmintic.

ATRIPLEX Linn. CHENOPODIACEAE

A genus of bushy plants, comprising about 180 species, distributed in sub-tropical and temperate regions. Five species occur in India.

The plants are drought-resistant and can thrive even under severe conditions. A few species like *A. nummularia* Lindl. are useful fodder plants and some others like *A. repens* Roth and *A. hortensis* are used as pot herbs.

A. hortensis Linn. ORACHE

D. E. P., I, 350 ; Fl. Br. Ind., V, 6.

HIND.—*Korake, surake.*

An annual plant with succulent branches and leaves, cultivated in the plains of Bengal and the Deccan. It occurs wild in the trans-Indus region.

It has a stronger flavour than spinach (*Spinacia oleracea* Linn.) and is recommended for cultivation in plains (Knott, 205). The flour of the seeds is reported to be valuable in vitamin A deficiency (Henn, *Chem. Abstr.*, 1941, **35**, 581).

ATROPA Linn. SOLANACEAE

D. E. P., I, 351; C. P., 95.

The genus *Atropa* comprises 4 species of medicinal plants, distributed in the Mediterranean region, southern Europe, and Asia. Of these, *A. belladonna* has long been a reputed drug in Europe, but its properties do not seem to have attracted the attention of Indian systems of medicine. *A. belladonna*, the common European species, is cultivated in some places on the Himalayas. The species found wild in India is *A. acuminata*.

A. acuminata Royle INDIAN ATROPA, INDIAN BELLADONNA

Fl. Br. Ind., IV, 241 ; Pl. XXI, 1 & 3.

A tall straight plant, about 3–5′ high. The leaves are stalked, elliptic-lanceolate, acuminate, 3–6″ long, and 2–4″ broad. The aerial shoots die every autumn and new ones arise in the following year, and form a large crown. The plant has a large taproot with many lateral rootlets. They are woody, pale-brown in colour, 6″ or more in length, and $\frac{3}{8}$–$\frac{3}{4}$″ diameter. They have short transverse scars due to the folding of outer bark. The bell-shaped flowers are solitary, short-stalked, about an inch long and are generally yellow in colour. The fruit is a purple-black berry of the size of a cherry.

A species of *Phytopthora*, a root fungus, which causes havoc in European belladonna plantations, has not been reported in India (Chopra, 67).

The plant is wild in Mozufferabad, Kanawar (8,500′), and other places in Kashmir. It also occurs in Baluchistan. During the collection of leaves a portion of stem is also removed. The rest of the plant is then uprooted and dried.

Official recognition has been given to the use of Indian belladonna, *A. acuminata*, in the 5th Addendum to the B.P. According to Chopra and Ghose (*J. Indian med. Res.*, 1926, **13**, 535), the total alkaloid content in the Himalayan plant is 0·81% in roots, and 0·5% in leaves. The constituents of Indian belladonna leaves resemble those of the European species (*vide infra*) and commercial samples contain 0·13–0·78% of alkaloids calculated as hyoscyamine, with an average of 0·45%, and the proportion of non-alkaloidal volatile bases in the leaves is said to be not greater than in *A. belladonna* (Denston, 102). Commercial samples of Indian roots contain 0·29–0·8% of alkaloids calculated as hyoscyamine, with an average of 0·47%. The alkaloidal percentage in root-stocks and stem bases is appreciable, though much lower than in roots. Commercial samples of

roots always contain more than 25% of rootstock and stem bases, and seldom less than 0·4% of non-volatile alkaloids.

Indian belladonna roots have been found to contain a larger proportion of volatile bases which do not possess the therapeutic activity of hyoscyamine. Special precautions have to be taken when assaying Indian belladonna. The alkaloidal residue should be dried at 100° for two hours, or until moistened red litmus paper held above the heated alkaloidal residue does not change colour (Allport, 31).

Indian *Atropa* was exploited during World War I and large quantities of roots were exported from Hazara and other outlying parts of the Himalayas. The drug, unless carefully collected, is liable to contain immature roots and adulterants. Indian belladonna is now used in India also for the manufacture of tinctures, plasters, etc. The roots may serve as a source of atropine. A small quantity of the alkaloid was manufactured from them in India during the last War ('39-45).

A. belladonna Linn. DEADLY NIGHTSHADE, BELLADONNA

Bentley & Trimen, III, 193 ; Pl. XXI, 2.

This tall branching perennial herb widely distributed throughout central and southern Europe also grows wild in southern England. It is cultivated for medicinal purposes in England, central Europe, and on an increasingly large scale in the U. S. A. It is grown to a small extent in Kashmir. Its flowers are yellowish-purple.

In England, the plant is grown from seeds sown in March or April, in warm, shady places, not exposed to direct sunlight. The soil should be light, calcarious, well-drained but capable of retaining moisture. It should also have requisite quantities of minerals like potash and soda (*Bull. Minist. Agric. Lond.*, No. 121, 1944, 4). Like *Asparagus* the plant can also be cultivated by splitting old rootstocks.

In India, Leake (*Agric. J. India*, 1907, **2**, 210) made some attempts to cultivate this plant in the Kumaon hills, with fairly encouraging results, though it failed in Mussoorie. The plant contains several alkaloids, chiefly *l*-hyoscyamine, $C_{17}H_{23}O_3N$ and small amounts of atropine, its optically inactive isomer (formed probably by the racemisation of the former) and small amounts of hyoscine (scopolamine), $C_{17}H_{21}O_4N$. In addition, there are small quantities of volatile bases, such as pyridine and N methyl- pyrroline, which, if not removed by heating during the assay of the drug will finally appear as hyoscyamine. The leaves also contain β-methylaes culetin (scopoletin), succinic acid, asparagin, etc.

Belladonna is used in medicine in two forms. *Belladonnae folium* and *Belladonnae radix*. The former is mainly used in the preparation of medicines for internal use, and the latter, in the preparation of galenicals meant for external application. Several preparations, such as tincture, extract, ointment, etc., are official in the B. P. *Belladonnae folium* consists of dried leaves and tops, collected when the plant is in flower. The first main crop of leaves is taken when the plant is a year old, but only plants 3–4 years old are sufficiently developed to give a good yield of roots. In England, the yield per acre of fresh herb is said to be 5–6 tons per crop. Usually two crops of leaves are obtained every summer. The leaves are dried rapidly at 45° (in well-ventilated rooms with heating arrangement), till reduced by about 18% of their weight and are stored with care. Otherwise they deteriorate rapidly and give off ammonia. The alkaloid content (as hyoscyamine) varies from 0·15–0·7%, the average being 0·4%. The B.P. minimum is 0·3%.

Belladonnae radix, the dried roots (alkaloids as hyoscyamine, 0·60–0·66% ; B.P. minimum, 0·4%) are generally harvested in autumn. They are richest in alkaloids when a year old (0·72%), but it is not profitable to take them out on account of their small size. After collection, the roots are washed, the large ones sliced, and rapidly dried.

Belladonna has a stimulating effect on respiration and circulation. It checks the action of the secretory glands and has a sedative action on the movements of the stomach, intestines, uterus, bladder, etc. It possesses the property of overcoming the spasm of involuntary muscles, dilating pupils and relieving pain when applied externally. It finds manifold uses as a stimulant, antispasmodic, and sedative. It is a valuable antidote in cases of poisoning by opium, muscarine, chloral hydrate, etc., which have a strong depressant action.

Belladonna is a highly toxic drug. Tincture belladonna is standardized to contain 0·03% of alkaloid, and is administered in doses of 5–30 minims. Doses larger than these are toxic. The immediate

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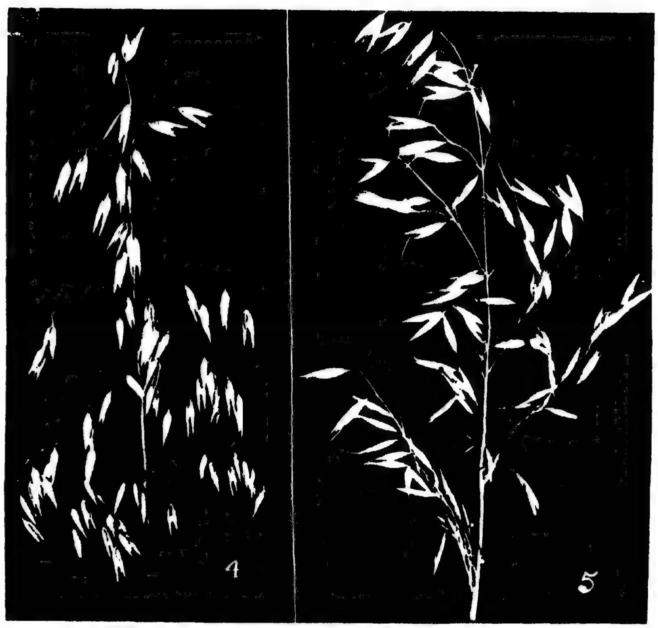


1. ATROPA ACUMINATA

2. ATROPA BELLADONNA

3. BELLADONNA ROOTS (ATROPA ACUMINATA)

4. AVENA BYZANTINA

5. AVENA SATIVA

effects of belladonna poisoning are dryness of mouth, throat and skin, dilatation of pupils and giddiness. These are followed by a failure of the respiratory system, resulting in death.

Morphine in moderate doses, administered after washing or emptying the stomach by emetics, is recommended. Artificial respiration and inhalation of carbon dioxide and oxygen are useful in the early stage of depression (Hale White, 26).

Atis root, see **Aconitum heterophyllum**

Attar of roses, see **Rosa damascena**

ATYLOSIA Wight & Arn. LEGUMINOSAE

Fl. Br. Ind., II, 212.

A genus of 20 species of climbers, occurring in tropical Asia, Australia, Madagascar and West Africa. *A. goensis* Dalz. (syn. *A. barbata* Baker) is said to be beneficial in rheumatism, biliousness and fever (Chopra, 465). *A goensis* and *A. scarabaeoides* Benth. are useful for green manure (Burkill, I, 267).

AUCUBA Thunb. CORNACEAE

This is a genus of small trees, consisting of 3 species. *A. japonica* Thunb. native to Japan is an ornamental shrub. *A. himalaica* is the only Indian species.

A. himalaica Hook. f. & Thoms.

D. E. P., I, 353 ; Fl. Br. Ind., II, 747.

NEPAL—*Phul amphi* ; LEPCHA—*Singha, tapathyer*.

A small slow-growing tree found in eastern Himalayas. Its wood is hard and black when freshly cut (wt., 55 lb. per c. ft.), but gets a lighter tinge on exposure. It has a good silver grain and may be used for inlaying and small carvings (Gamble, 392).

Avarum, see **Cassia auriculata**

AVENA Linn. GRAMINEAE

D. E. P., I, 354 ; C. P., 96.

A large genus of annual or perennial grasses, comprising about 70 species, found chiefly in temperate and sub-tropical regions. Of the species met with in India, 14 have been identified.

A. sativa, the oat, is an important cereal and fodder crop of Europe and America. The U. S. A. (Iowa, Illinois and Minnesota), and the U. S. S. R. are the largest oats-producing centres in the world. *A. brevis* Roth (the Short Oat), *A. nuda* Linn. (the Naked Oat), and *A. orientalis* Schreb. (the Hungarian or Turkish Oat), are some of the other grain-yielding species.

The oat in India was considered to be from *A. sativa*. But Bose (*Agric. J. India*, 1929, **24**, 170) has shown that the species cultivated in India is *A. sterilis* var. *culta* now known as *A. byzantina* (*vide* also Shaw & Bose, *Indian J. agric. Sci.*, 1933, **3**, 754). *A. sativa* is usually cultivated only for fodder.

A. barbata Brot. (western Himalayas and Kumaon), *A. fatua* Linn. (Punjab and north-western Himalayas), *A. pratensis* Linn.[=*Helictotrichon pratense* (Linn.) Pilger] (Garhwal to Kulu), and *A. pubescens* Huds. (Simla) are some of the grasses which are useful as fodder. *A. fatua*, called the Wild Oat, is suspected of occasionally producing bad effects.

A. byzantina C. Koch Syn. *A. sterilis* var. *culta* Linn. INDIAN OAT

Fl. Br. Ind., VII, 275 ; Pl. XXI, 4.

HIND.—*Javi* ; MAR. & GUJ.—*Jav* ; TEL.—*Yavalu*.

This is an early-maturing annual grass with a somewhat sub-erect stem having 3–5 nodes, bearing yellowish-green, tapering, narrow leaves, and producing erect, spreading, equilateral panicles. The awned spikelets enclose usually 2, rarely 3, yellowish grains (about 2 cm. long, 3 mm. broad and 2 mm. thick).

It differs only slightly from *A. sativa* and is generally cultivated in countries around the Mediterranean and in tropical and sub-tropical regions. In India, it is found from Bengal to the Indus, and in the Himalayas up to 12,000′, but is cultivated principally in Meerut and Rohilkhand divisions of the U.P., and Hissar and Karnal dists. of the Punjab. It is generally grown as a minor *rabi* crop (winter crop) in a wide range of soils, but grows best on friable loam, or soils suitable for wheat and barley.

Two high yielding and drought-resistant strains (selections from country oat) evolved at Pusa are B. S. 1 and B. S. 2. A number of promising hybrids

of *A. sativa* and *A. byzantina* have been produced at Pusa, combining good grain yielding and profuse straw-producing qualities of the former, with early maturity and drought-resistance of the latter (Shaw and Bose, *loc. cit.*, 769 and 807). In the Punjab, Pusa hybrid 'J' has been found to be the best among early maturing oats, both for green fodder and for grain-yield, while among late and coarse varieties, 'French' and 'Golden Rain' gave best yields on rich soil with an ample supply of water. The finer types, Algerian and Fodder specialist's selection 1/29, are not exacting in their soil and water requirements, and hence they are the only two types preferred for cultivation under '*barani*' (dry) conditions (*Agric. & Anim. Husb. India*, 1936-37, 133).

The seeds are sown broadcast, or drilled, in October or November, and the crop is harvested during March-April. Seed rate varies from 70–100 lb. per acre, and yield per acre on an average is 18 mds. on irrigated, and 10 mds. on unirrigated land, with about 30 mds. of straw. At Pusa, with improved strains, high yields ranging from 25–35 mds. of grain per acre, have been obtained on unirrigated land (Shaw and Bose, *loc. cit.*, 756).

Experiments conducted at Pusa showed that green manuring with *Crotalaria minjussi* gave better results than with sunn-hemp (*Crotalaria juncea*), *Dhanchia* (*Sesbania aculeata*), *Guara* (*Cyamopsis psoralioides*) and cowpeas (*Vigna sinensis*). Green manure in conjunction with superphosphate gave a higher yield than when green manure alone was used; also sunn-hemp (six weeks old) plus superphos. ($\frac{3}{4}$ md. per acre) gave a very good out-turn, but fermented sunn-hemp by itself, or supplemented with superphos. gave the highest out-turn (*Agric. & Anim. Husb. India*, 1937-38, 84).

The cultivation of oats during *rabi* season for green fodder is a regular practice on most government farms in Sind and other places. It gives 2–3 cuttings of fodder, and finally, a small crop of grains. The seed rate for fodder crop is 60–100 lb. per acre. Seeds are sown drilled in lines from October to December, every fortnight, thus ensuring a continuous supply of green fodder from January to April. The crop requires 4–6 light irrigations. A good uniform growth will yield up to 300 mds. of green fodder per acre in the first cutting, and about 100 mds. in the second cutting. If the second cutting is omitted, the crop may yield about 10 mds. of grain per acre (*Dep. Agric., Sind, Leafl.*, No. 26, 1933).

Two fungal diseases, the covered smut and the loose smut, affect the crop rather seriously in India. The covered smut (*Ustilago kolleri* Wille), has been found to be a wide-spread disease. Some resistant types of oats have been evolved at the Imperial Agricultural Research Institute (Bose and Mundkur, *Indian J. agric. Sci.*, 1941, **11**, 695).

Oats are used in this country mainly as fodder for horses and cattle. The seeds and *bhusa* (husk) form an important concentrated cattle food. Recently, some processed foods from Indian oats are being manufactured on a small scale.

Indian oatmeal has the following composition: moisture, 10·7; protein, 13·6; fat, 7·6; carbohydrates, 62·8; mineral matter, 1·8; Ca, 0·05; P, 0·38%; Fe, 3·8 mg./100 g.; vitamin B, 325 I.U. /100g.; and cal. val., 374/100 g. (*Hlth. Bull.*, No. 23, 1941, 26). Nicotinic acid is present only in traces, 1·1 mg./100 g. (Aykroyd and Swaminathan, *Indian J. med. Res.*, 1940, **27**, 667).

A small quantity of oats was being exported from Calcutta, chiefly to Ceylon, Mauritius and other British dependencies. Between 1929 and 44', the annual exports averaged 91 tons valued at Rs. 11,210. There was no export in 1944-45. While export price in 1938-39 was Rs. 108 per ton, in 1943-44, it reached a peak value of Rs. 412 per ton.

A. sativa Linn. THE OAT

Fl. Br. Ind., VII, 275; Pl. XXI, 5.

An erect, tufted, annual grass, 2–5′ tall, with terminal panicles 6–12″ long, bearing large ($\frac{3}{4}$–1″) drooping, awned spikelets. The leaves are abundant, and bluish green in colour. The grain ($\frac{1}{4}$–$\frac{1}{3}$″ long) is narrow, hairy, and grooved lengthwise.

This species is not a homogenous one and is considered to be derived mostly from *A. fatua*, and a few of its races from *A. sterilis* Linn. and *A. barbata* (Bailey, 1944, 114).

In India, *A. sativa* has not proved successful as a cereal crop as it takes too long a period for the grains to mature. But it yields an excellent crop of green fodder, for which it is cultivated around cantonments in northern India.

Oats form one of the most nutritious of all cereals for human use, but the chief disadvantage is the difficulty in removing the large proportion of hulls

(20–30%) from the grains. Rolled oats prepared by machinery, and oatmeal obtained by coarse grinding, have become common articles of breakfast (porridge) in Europe and America. But even now a greater proportion of the crop is consumed as fodder for domestic animals, pigs excepted.

Oats are particularly rich in fat and proteins, according to Murlin, Nasset and Marsh (*J. Nutrit.*, 1938, **16**, 249). The replacement value of pre-cooked oats in terms of whole egg protein is of the order of 87%, and its biological value, 98%. In these respects, it is followed by wheat.

English oatmeal has the following average composition: moisture, 8; protein, 14; ether extract, 7; carbohydrates, 68; crude fibre, 1; ash, 1·7 %; cal. val., 391 cals./100g. or about 1770 cals./ lb.(Moir, *Chem. & Industr.* 1942, **61**, 17). The whole grain is reported to contain vitamin B_1, 480–1030 µg.; and oatmeal, 285-975 µg./100g. (Booher, Hortzler, & Hewston, 134.)

The protein in oats does not occur in the form of gluten. Hence oatmeal flour is not suited to bread making. The diastatic activity of oat-malt is only 7·5-18% lower than that of barley malt (*Chem. Abstr.*, 1932, **26**, 1384).

Oat straw is a valuable fodder since it is cut while transference of food to ripening grain is still incomplete. The entire plant contains about 2-3% albuminoids and 3–4% total sugars. The straw is rich in pentosans and contains a little fat and wax (Wehmer, I, 80). The vitamin A content of the plant (6,000–12,500 I. U./100g.) depends upon its growth (Booher, *et al.*, *loc. cit.*).

Oat hulls contain 32-36% pentosans, 35% cellulose, and 10–15% lignin. They form the most economic source of furfural. In 1922, the Quaker Oats Company, Chicago, developed a process for the manufacture of furfural from oat hulls obtained during the manufacture of rolled oats and oatmeal, and they are now the largest producers of the material. The ground hulls are digested with sulphuric acid under pressure when the pentosans are transformed into furfural. The yield on the weight of the hulls is about 10%, and the process is roughly 50% efficient (Hammer, *Chem. & Industr.*, 1933, **52**, 608).

Furfural has been used for the manufacture of synthetic resins by condensing it with phenols, ketones and amines, but most of these resins are dark in colour. Furfural also finds application in the manufacture of certain fungicides, disinfectants and preservatives. It is a valuable industrial solvent. Very recently furfural has been used as an adjunct to asphalt, and small quantities are reported to improve the adhesion of the latter to a remarkable degree. A number of chemicals and solvents derived from furfural are finding industrial application.

AVERRHOA Linn. OXALIDACEAE

D. E. P., I, 359; Fl. Br. Ind., I, 439.

A small genus of three or four tropical species of evergreen trees. Two of the species (*A. carambola*, and *A. bilimbi*) are cultivated for their fruits. Duthie (I, 132) suggests that these have been introduced into India from America by the Portuguese, while Burkill does not think that the genus is American.

A. bilimbi Linn. BILIMBI, TREE SORREL

D. E. P., I, 359; C. P., 97; Fl. Br. Ind., I, 439; Beddome, I, Pl. 117.

Indian names are mostly derived from 'Bilimbi'.

A medium-sized tree, bearing clusters of cucumber-shaped, greenish yellow fruits which are about 2″ long, sour, and juicy. Each fruit contains a few flattened seeds.

It has been naturalised in India and has run wild in the tropical parts of the country. The plant is propagated by seed. Budding has been tried and found unsuccessful. It is grown in gardens throughout the plains, and is also cultivated in Burma and Ceylon. The tree yields fruits during midsummer.

The fruit is edible and can be made into pickles and preserves. It also yields a refreshing beverage. Cabbab and Soliven (*Philip. Agric.*, 1938, **26**, 644,) found the fruit to contain 42·2% of juice of pH, 4·47.

The wood is white, tough, soft and even-grained.

A. carambola Linn. CARAMBOLA

D. E. P., I, 359; C. P., 97; Fl. Br. Ind., I, 439; Pl. XVII, 4.

Most Indian names are derived from 'Kamrakh'.

A small handsome evergreen tree 15–30′ high with flowers springing from the bark, and acutely five-angled, ovoid fruits 3-4″ long, watery, translucent, fragrant, and of a rich amber or golden yellow colour. When green they are astringent, but on ripening, develop a sweetish acid taste.

Carambola is well established throughout the country. The tree is essentially tropical and prefers a warm moist climate. In India, it flowers during June–September, and fruits during September–October and December–January. Though there are no established horticultural varieties, two forms, sour and sweet, are sometimes distinguished, the latter being frequently found in Bengal. The propagation is done by seed, but budding and grafting are also possible.

The fruits are made into stews, curries, puddings, and tarts. The sweeter ones are eaten as dessert. The slightly unripe ones are made into jams, jellies, pickles and preserves. The flowers also are sometimes made into preserves. Carambola crush can be a refreshing drink.

The acid fruits are often used for cleaning metal surfaces, especially for removing rust stains.

The fruits of the sweet variety have been found to contain: moisture, 93·9; protein 0·5; fat, 0·2; carbohydrate, 4·8; mineral matter, 0·2%; iron, 0·6 mg.; vitamin A, 240 I.U./100g.; (*Hlth. Bull.*, No. 23, 1941, 38; *vide* also Wehmer, I, 592): the acid content is given as 0·8 per cent. by Thompson (ex Popenoe, 431).

The wood (wt., 40 lb. per c.ft.) is white (turning reddish), close-grained and moderately hard. It is reported to have been utilized in the Sunderbans for building purposes and for furniture.

AVICENNIA Linn. VERBENACEAE

The genus comprises four halophytic species which, along with others, constitute the tropical mangrove formations. Of these, *A. officinalis*, *A. alba* Blume, *A. marina* Vierh. are found in India. These plants grow mostly on sea-shores and along the edges of estuaries.

A. officinalis Linn. THE WHITE MANGROVE

D. E. P., I, 360; C. P., 98; Fl. Br. Ind., IV, 604.

HIND. & BENG.—*Bina*; MAR.—*Tivar*; GUJ.—*Tavariyan*; TEL.—*Mada*; BURMA—*Thame*.

It is a shrub or small tree of the salt marshes and tidal forests of India, Burma, Ceylon, and the Andaman Islands. In the Sundarbans, it grows to a fairly big tree, 40–60′ high, with a girth of 12–15′. On the Coromandel coast it is generally a bush. It is also common along the coasts of Burma.

Two or three varieties are differentiated by the colour of bark, which may be black, white or mottled.

The wood is brittle and coarse-grained, and is used only as fuel. On account of its attractive grain, the wood may find a place in small cabinet work, and is recommended for trial as creosoted paving blocks (Brown, I, 80).

The wood from Tanganyika was found to contain cellulose, 54·7% and ash, 2·3% of moisture-free wood. In paper making trials, it was readily pulped by the soda process, on account of the shortness of its fibres. The pulp, however, was not easily bleachable. Besides, the wood chipped badly producing a large proportion of waste (*Bull. imp. Inst., Lond.*, 1939, **37**, 336). Wells has examined the tar prepared from the wood (*Philip. J. Sci.*, 1917, **12**, 111), and the wood-ash is reported to be rich in alkali (Baker, ex Burkill, I, 274).

The tannin content of the bark is only 2·5% (Pilgrim, *Indian For. Rec.*, 1924, **10**, 238) with 12% of non-tannins (*Indian For. Leafl.*, No. 72, 1944, 5). The kernel of the fruit, though bitter, is reported to be edible. The leaves are used as cattle fodder in Australia (Paranjpye, *Agric. J. India*, 1920, **15**, 350). The green, bitter and somewhat aromatic resin which oozes from the bark is said to possess medicinal properties (Burkill, I, 274).

AZADIRACHTA A. Juss. MELIACEAE

This is a genus of tall, evergreen trees, comprising two species. *A. indica*, native to India, is now widely distributed throughout the Indo-Malayan region and is also found in tropical Africa. *A. integrifolia* Merril is indigenous to the Philippines.

A. indica A. Juss. Syn. *Melia azadirachta* Linn. NEEM TREE, MARGOSA TREE

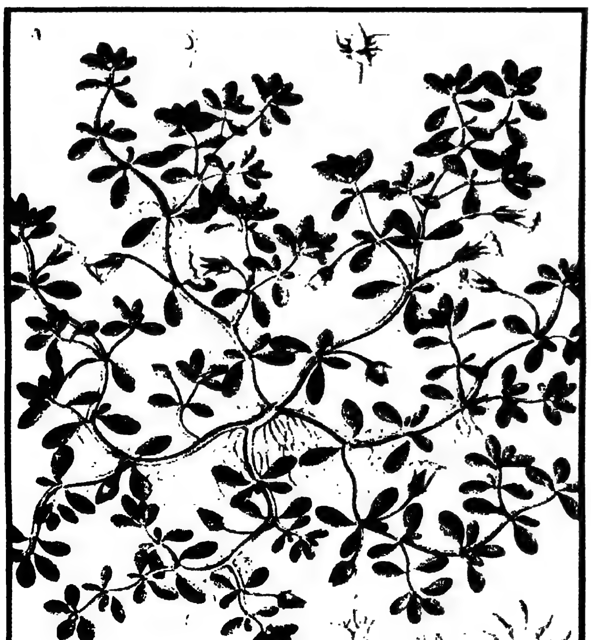
D. E. P., V, 211; C. P., 780; Fl. Br. Ind., I, 54; Pl. XXII, 1.

SANS.—*Nimba*; PERS.—*Nib, azad-darakht-hindi*; HIND. & BENG.—*Nim*; MAR. & GUJ.—*Limba*; TEL., TAM. & MAL.—*Vepa*; KAN.—*Bevu*.

This is a medium-sized tree, with a clear bole of 10–25′, and a girth of 6–8′. Although described as evergreen, in drier areas it becomes deciduous. Its bark is moderately thick with longitudinal or oblique furrows on the outer surface. It is dark-grey outside and reddish inside. The flowers

1. AZADIRACHTA INDICA

2. AZIMA TETRACANTHA



3. BACOPA MONNIERA

4. BALANITES AEGYPTIACA

appear from March–May and the fruits ripen during June–August. They are greenish yellow when ripe, and usually contain only one seed.

The tree grows wild in the dry forests of the Deccan and in the open scrub forests of the dry zone of Burma. It is cultivated all over India and Burma, but thrives best in the drier climate of the north-western parts, where normal rainfall varies from 18–45 inches and maximum shade temperature may be as high as 120°F. It grows on all kinds of soils but does well on black cotton soil. It is well suited for afforestation in dry situations and is a common avenue tree.

Almost every part of the tree is bitter and has found application in indigenous medicine. The seed oil (margosa oil) is acrid, yellow, bitter in taste, and has a disagreeable garlic-like odour. It is used in skin diseases such as scrofula, indolent ulcers, and sores, and ringworm. It is also applied in cases of rheumatism as a liniment. It is reputed to possess anthelmintic and insecticidal properties.

The bitter principles of neem oil have been investigated by several workers (Watson & Chatterjee, *J. Soc. chem. Ind., Lond.*, 1923, **42**, 387T; Murti, Rangaswami & Seshadri, *Indian J. Pharm.*, 1940, **2**, 206). Siddique and Mitra (*J. sci. industr. Res.*, 1945, **4**, 5) have recently obtained the bitter principles by extraction with alcohol (yield, 2%). Nimbidin (m.p., 90–100° ; 1·2–1·6%), the principal component, is highly bitter and contains sulphur. On hydrolysis, it gives nimbidinic acid which is equally bitter and retains sulphur. Besides nimbidin, two bitter compounds, free from sulphur, (m.p., 192°, and 205°), have been obtained in very small quantities. Nimbidin and sodium nimbidinate are almost non-toxic (m.l.d. for frogs, 0·25 mg. per g. body wt.). Nimbidin preparations are reported to be free from the unpleasant smell of the oil and to be efficacious in a variety of skin diseases, sceptic sores, and ulcers due to burns, and useful in bleeding gums and pyorrhoea.

The bark is a good bitter tonic, astringent and antiperiodic. It is said to contain a resinous bitter principle and is usually prescribed in the form of a tincture or an infusion (Birdwood, 104). It is also regarded as beneficial in malarial fever. But, preliminary experiments carried out recently, at the School of Tropical Medicine, Calcutta, have shown that a tincture (1 : 10) made from the dried and powdered bark has no action on 'monkey malaria' or malaria in human beings (Mukerjee, Private communication; cf. Central Indigenous Drugs Comm., 3rd Rep., 1916, 185; and Koman, 1919, 18).

The bark also is considered useful in skin diseases (Koman, *loc. cit.*). The leaves are bitter and have a faint, but characteristic unpleasant smell. Dried in the shade, they are commonly placed in books, paper and clothes to protect them from moths, etc. The odour produced by the burning of powdered leaves is said to be fatal to insects. The leaves are applied to boils in the form of a poultice, and a decoction is recommended in ulcers and eczema. The dry flowers are considered tonic and stomachic. The berries are regarded as purgative, emollient and anthelmintic. But, Caius and Mhaskar (*Indian J. med. Res.*, 1923, **11**, 364) have shown that the juice of the leaves and the oil do not have any anthelmintic properties. Fresh tender twigs are used to clean teeth, particularly in pyorrhoea. The presence of the tree around villages and on road-sides is considered beneficial.

The seeds are reported to contain up to 45% of oil. According to Rao and Seshadri (*Proc. Indian Acad. Sci.*, 1942, **15**, 161) the oil has the following constants: $d/31°$, 0·9129; $n_D/31°$, 1·4658; sap. val., 195·6; iod. val., 69·2; acid val., 11·2. The fatty acids are chiefly oleic (about, 53%), stearic (about 18%), and palmitic (about 14%), together with small amounts of linoleic and arachidic acids. The 'margosic acid' of earlier workers was shown by Roy and Dutt (*J. Soc. chem. Ind., Lond.*, 1929, **48**, 333T; see also Child and Ramanathan, *ibid.*, 1936, **55**, 124T) to be a mixture of the usual fatty acids. The glycerides of neem oil have been investigated by Hilditch and Murti (*ibid.*, 1939, **58**, 310T) and found to follow the usual rules of glyceride structure in seeds and fats. Investigations on the odorous constituents of the oil which are considered to be sulphur compounds have so far been inconclusive (*vide* Murti, Rangaswami and Seshadri, *loc. cit.*).

In India, the oil is usually prepared in *ghanis* (wooden oil mills) for local use, either as medicine or as an illuminant. However, while burning, it smokes badly. If seeds are heated before crushing, the odour becomes intolerable. The oil gives soap of unattractive brown colour which still retains some smell. This could be considerably decreased by a second boiling, and by salting out the soap. The soap produces a profuse though slightly

greasy lather. Neem oil could be mixed with other oils and fats for the manufacture of washing soap (Datta, Basu and Nandy, *Dep. Industr., Bengal, Bull. No.* 47, 1936). Considerable quantities of the oil are used for the preparation of cheap washing soap. Medicated soaps with the odour of neem are found in the market.

The oil cake is regarded as a useful fertilizer (moisture, 6–8·7; organic matter, 84–89; inorganic matter, 1·69–5·07; salts, 3–9; P_2O_5, 0·68–1·4%).

The gum which exudes from the bark occurs in the form of clear bright amber coloured tears or fragments. It is found mixed with gum ghatti. It contains: water, 13–15; ash, 3; galactans, 12; pentosans, 26%; some albumins and oxidase (Wehmer, II, 662; and Koolhaus, *Chem. Abstr.*, 1940, **34**, 6118).

A sweet liquid, neem toddy is occasionally obtained as an exudation from the upper parts of some trees. It has the unpleasant odour of neem and contains: sugars, 6·5, and albuminous and gummy matter, about 6·5% (Ghosh, *Indian For.*, 1913, **39**, 264).

The wood is moderately heavy, medium-textured, and narrowly interlocked-grained (sp. gr., 0·68; air-dry wt., 44 lb. per c. ft). The sapwood is greyish-white. The heartwood is red when first exposed, and later turns reddish-brown. It is not very lustrous, and is slightly aromatic. Anatomically it is featured by distinct growth rings, medium-sized vessels occluded by reddish-brown gum, parenchyma cells with deposits of gum, and fine rays. The wood has often been mistaken for that of *Melia azedarach* Linn., but can be easily distinguished as the latter is one of the few ring porous woods of India (Pearson and Brown, I, 253).

The timber seasons well, and is durable even in exposed situations. It is not attacked by white ants, perhaps due to its bitter character. It is not difficult to saw. It can be worked both by hand and by machine, and is suitable for carving, but it does not take polish well. The timber is used in housebuilding and for making boards, panels, toys and ploughs (Pearson and Brown, *loc. cit.*).

AZIMA Lam. SALVADORACEAE

A genus of thorny shrubs comprising 3 species, occurring in tropical Africa and Asia.

A. tetracantha Lam.

D. E. P., I, 361; Fl. Br. Ind., III, 620; Pl. XXII, 2.

SANS.—*Kundali*; HIND.—*Kantagur-kamai*; BENG.—*Trikanta-gati*; MAR.—*Sukka-pal*; TEL.—*Tella-upi*; TAM.—*Ichanka*.

A rambling spinous shrub, flowering throughout the year and bearing globose 1-2 seeded, white berries, about ¼" in diameter.

It is often found gregarious in the drier districts of the Deccan Peninsula, especially near the coast, and in Orissa, Sundarbans, Ceylon and Burma.

The juice of the leaves is said to relieve the cough of phthisis and asthma. The bark is reputed to be an expectorant.

It is a good hedge plant. The berries are edible.

Babar or **Bhabar grass,** see **Eulaliopsis binata**

Babul, see **Acacia arabica**

BACCAUREA Lour. EUPHORBIACEAE

A genus of evergreen trees, comprising about 100 species mostly of Indo-Malayan origin. Of these, some 29 are found in India and a few extend to tropical Africa and Polynesia.

The trees often produce fruits in great abundance. The pulp and the juicy aril of some are edible. The fruits are generally acidic, but those of *B. dulcis* Muell. Arg. of Malay, Sumatra and Java are sweet. In Malay, a fermented liquor is made from the fruits of some species.

B. courtallensis Muell. Arg. (the Western Ghats from N. Canara to Travancore), *B. parviflora* Muell. Arg. (Tenasserim) and *B. sapida* yield edible fruits of sour taste. The timber of these species is said to be useful, but has not been exploited.

B. sapida Muell. Arg.

D. E. P., I, 362; Fl. Br. Ind., V, 371; Brandis, Fig. 181.

BENG.—*Latqua*; ASSAM—*Leteku*; BURM.—*Kanazo*.

This medium-sized tree occurs wild or cultivated in sub-Himalayan tracts, Assam, Burma and the Andamans. It prefers a deep moist soil and wet climate.

The yellow globose fruits, about an inch in diameter, possess a pleasant acid taste. According to Parkinson (239) they are not quite wholesome and should be eaten with caution.

In Siam, the flowers and leaves also are said to be eaten (Burkill, I, 281). The soft greyish-brown wood is liable to split badly (wt., ca. 42 lb. per c. ft.).

BACOPA Aubl. SCROPHULARIACEAE

A genus consisting of 20 species of small herbaceous plants, inhabiting the warm parts of the world, of which 3 are represented in India.

B. monniera Wettst. Syn. *Herpestis monniera* (Linn.) H. B. & K.

THYME LEAVED GRATIOLA

D. E. P., IV, 225; Fl. Br. Ind., IV, 272; Pl. XXII, 3.

SANS.—*Nira-brahmi*; BENG.— *Brihmi-sak*; MAR., TAM. & MAL.—*Nirbrahmi*; KAN.—*Nirubrahmi*.

A common, creeping annual, growing in damp or marshy areas, sometimes confused with *Hydrocotyle asiatica* (Umbelliferae), which is also known in some parts of India as *brahmi*.

The entire plant is used in indigenous medicine as a nerve tonic and as a cure for epilepsy and insanity. Koman (1919, 17 & 48) found *brahmighritha*, a medicated ghee prepared from *B. monniera*, beneficial in cases of epilepsy and hysteria. According to Bose (ex Chopra, 325) the powdered dried leaf gave satisfactory results in cases of asthenia, nervous breakdown and other low adynamic conditions. Its action is similar to that of strychnine, and it is also a direct cardiac tonic. It does not produce the reflex irritation often noticed when nux vomica or strychnine is administered for a long time.

Bose and Bose (ex Chopra, 326) have isolated a toxic alkaloid from the plant and called it 'brahmine'. Its therapeutic action resembles that of strychnine, but is less toxic.

BACTRIS Jacq. PALMAE

Blatter, 543.

A genus of slender, ornamental palms comprising 90 species, indigenous to South America. Several species yield edible fruits and oil-seeds. Some, such as *B. major* Jacq., are occasionally found in Indian gardens.

The fruit of *B. utilis* Benth. and Hook. f., a tall species found in Central America and the northern parts of South America, where it is known as *Pejibaye*, is generally eaten cooked, but it can also be dried and made into flour (Popenoe and Jimenez, *J. Hered.*, 1921, **12**, 154). This palm is regarded as the American counterpart of the Oriental date palm.

Bahama or **Bermuda grass,** see **Cynodon dactylon**

Bajra, see **Pennisetum typhoi**

BALANITES Delile SIMAROUBACEAE

A genus of 2 or 3 species of small spiny trees, distributed from Africa to Burma. The kernel of the fruits is rich in oil. *B. aegyptiaca* Delile is indigenous to the Nile valley and has been known to the Egyptians for over 4,000 years. The stones of its fruits have been found in tombs of the Twelfth Dynasty.

The Indian species is named *B. roxburghii*. Some consider it to be identical with *B. aegyptiaca*, but others treat it as different.

B. triflora Van Tiegh. which resembles *B. roxburghii* is found in the dry forests of upper Burma (Rodger, 45 and 98).

B. aegyptiaca (Linn.). Delile Syn. *B. roxburghii* Planch

D. E. P., I, 363; Fl. Br. Ind., I, 522; Pl. XXI, 14.

SANS.—*Ingudi*; HIND.—*Hingan, hingot*; MAR.—*Hinganabet*; GUJ.—*Regorea*; TEL.- *Gari*; TAM.—*Nanjunda*.

A small spiny tree, about 20′ high, with bifoliate ashy-green leaves. The fruits which ripen in winter are ovoid drupes, about 2″ in length. The pulp is sweet, but has an unpleasant smell. The stone encloses a single oily seed. This tree is characteristic of the drier parts of India and Burma and is found chiefly on black cotton soil. It does not thrive in rocky areas.

The pulp of the fruit is edible and is reported to be used for cleaning silk and cotton. It contains some saponin and is not astringent (Hooper, *Agric. Ledger*, 1902, **9**, 20).

The kernel of seeds yields 43% of a bland yellow tasteless oil, which has the following characteristics: sp. gr./15°, 0·9185; $n_D^{40°}$, 1·46; sap. val., 195·2; iod. val., 88·3 (Patel, *Curr. Sci.*, 1943, **12**, 58; cf. Hooper, *Agric. Ledger*, 1911-12, **17**, 130).

The kernel of seeds from Uganda yields 46·8% of a golden yellow oil suitable for soap making. But it is difficult to separate the nut from the sticky pulp and to remove the kernel (8·8%) from the thick fibrous shell (*Bull. imp. Inst., Lond.*, 1935, **33**, 271).

The seeds, fruits, bark and leaves are reported to be anthelmintic and purgative. In western India, the bark is used as an anthelmintic for cattle, and its juice as fish poison in Panch Mahals, Bombay.

The nuts are made into crackers by drilling small holes, removing the kernel and filling them with gun powder.

The wood is yellowish-white and moderately hard (wt., 48 lb. per c. ft.). It is chiefly used for walking sticks, and for fuel.

BALANOCARPUS Bedd. DIPTEROCARPACEAE

A genus of 16 species of deciduous medium-sized or tall trees, 3 of which occur in India and Ceylon. *B. utilis* is a valuable timber tree. Some of the Malayan species yield commercially important dammar, e.g. *damar penak* from *B. heimii* King.

B. utilis Bedd. Syn. *Hopea longifolia* Dyer

Fl. Br. Ind., I, 309; Beddome, II, Pl. 330.

TAM.—*Kong, karakong.*

A tall tree found on the Tinnevelly hills, south of Courtallum (Madras) at 1,000–3,000′. The distribution is very local.

According to Pearson and Brown (I, 124), the wood is of extremely fine texture (wt., ca. 65 lb. per c. ft.). It is difficult to season and is liable to surface-cracking. At present, it is mainly used in construction. Supplies, however, are very limited.

BALANOPHORA Forst. BALANOPHORACEAE

D. E. P., I, 364; Fl. Br. Ind., V, 237.

Balanophora is a genus of some 20 species of root-parasites, distributed in tropical and sub-tropical mountainous regions from India, eastwards to the New Hebrides. The plants possess a tuberous rhizome, connected by suckers to the roots of the host tree.

Some species, e.g. *B. elongata* Blume, *B. globosa* Jungh., and *B. ungeriana* Valeton of Java contain a large amount of waxy substance (balanophorin, m.p., 77°), in the parenchyma of the rhizome. This wax (from *B. elongata*) has been found to be β-amyrin-palmitate (Wehmer, I, 260). The rhizomes have been used by the natives of Java for illumination. They give a bright light, but burn with a smoky flame (Burkill, I, 288; cf., Howes, *Kew Bull.*, 1936, 505).

BALIOSPERMUM Blume EUPHORBIACEAE

A genus comprising about 10 species of shrubby plants, distributed from India to China and Java. 4–5 species occur in India, of which *B. montanum* is the most common. *B. micranthum* Muell. Arg. (which occurs in the Khasi and Jaintia hills) is used as a vegetable (Fl. Assam, IV, 204).

B. montanum Muell. Arg.

D. E. P., I, 364; Fl. Br. Ind., V, 462; Kirt. & Basu, Pl. 879.

SANS. & HIND.—*Danti.*

An erect undershrub up to 6′ high. The fruit is a 3-lobed capsule with mottled seeds and oily endosperm. The plant is distributed throughout the sub-Himalayan tract from Kashmir to Khasi Hills and it is very common in north and east Bengal. It also occurs in Chittagong, Chota-Nagpur, south India, Burma and Malaya.

The seeds resemble those of the castor plant and act as a drastic purgative. In overdoses they are highly poisonous. They are sometimes substituted for the seeds of *Croton tiglium* (*jamalgota*), and hence they are also called *jangli jamalgota*.

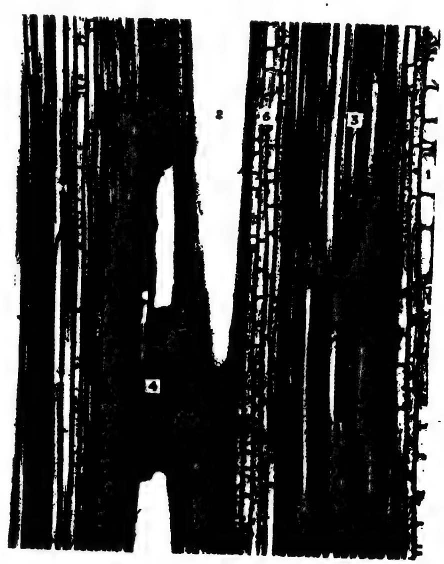
The oil from the seeds resembles croton oil and is a powerful hydrogogue cathartic. It is also useful in external application in rheumatism. The oil has the following constants: sp. gr. /15°, 0·938–0·943; sap. val., 207–215; iod. val., 99–106 (Krishna, Puntambekar and Raizada, *Indian For. Rec., New Series, Chem.*, 1936, **1**, 9).

The root is also cathartic, but its action is milder.

1. BAMBUSA ARUNDINACEA

2. DENDROCALAMUS STRICTUS

3. OCHLANDRA TRAVANCORICA



4. DENDROCALAMUS STRICTUS

Longitudinal section through a vascular bundle. 1. Fundamental tissue; 2. Pitted vessel; 3. Mechanical fibres; 4. Groups of sieve tubes with companion cells; 6. Paratracheal parenchyma.

Balsam, Garden—, see **Impatiens balsamina**

Balsamodendron Kunth, see **Commiphora**

BAMBOOS

GRAMINEAE

D. E. P., I, 370; C. P., 98; Fl. Br. Ind., VII, 375; Gamble, *Ann. R. bot. Gdn Calcutta*, 1896, 7.

Bamboos are tall arborescent grasses belonging to Bambuseae, a tribe of Gramineae, comprising four subtribes: Arundinarieae, Eubambuseae, Dendrocalameae, and Melocanneae. There are about 30 genera and 550 species, inhabiting the humid tropical and extra-tropical regions. Asia and South America account for most of them containing 320 and 179 species, respectively. 136 species occur in India, 39 in Burma, 29 in Malaya and the Andamans, 9 in Japan, 30 in the Philippines, 8 in New Guinea, and a few in South Africa and Queensland.

The more important genera of bamboos are *Arundinaria*, *Bambusa*, *Cephalostachyum*, *Dendrocalamus*, *Gigantochloa*, *Melocanna* and *Ochlandra*. Most of these are indigenous to India, Burma, south China and Malaya, and a few to South America. Some have been introduced into Europe, Australia, etc., and a few Japanese species are grown as ornamental plants.

Bamboos thrive best in monsoon forests where they attain their maximum development. They dwindle into undershrubs in temperate regions, and at high altitudes some species look almost like grasses. Bamboos form rich belts of vegetation in the well-drained parts of the monsoon region at the foot of the Himalayas, and rise up to about 12,000′, almost to the snow line. Their distribution is quite dense in Burma, Assam and Bengal, the north-eastern Himalayas, the Western Ghats, Ceylon, and the Andamans.

B. arundinacea is found in Orissa, Assam, eastern Bengal, south and western India, *B. vulgaris* in Assam, Burma, Java, South America and West Indies, *B. tulda* and *B. balcooa* in Bengal; *Arundinaria aristata* Gamble in eastern Himalayas, *A. wightiana* in the Nilgiris, *B. polymorpha* in the upper mixed forests of eastern Bengal and Assam, *Pseudostachyum polymorphum* in the valleys of eastern Himalayas, Assam, upper Burma and Sikkim and *Dendrocalamus strictus* in deciduous forests throughout India.

In their natural habitat, many species grow along with other bamboos, e.g. *B. tulda* grows with *Cephalostachyum pergracile* in the moist parts of Bengal and Pegu (Burma), or with *Dendrocalamus strictus* in the drier parts of east Bengal and Assam. *B. polymorpha* is common in the upper mixed forests of Martaban and Pegu Yomas, and it grows with teak in Assam and East Bengal.

VARIETIES

Bamboos differ widely in stature and form. *Dendrocalamus giganteus* is usually 120′ high, while the *Arundinarias* are mere shrubs. Most of them grow erect, but a few, such as *Teinostachyum helferi*, *Arundinaria prainii*, *Cephalostachyum capitatum* are stragglers, whereas *Melocalamus compactiflorus* Benth., and *Schizostachyum* Nees, the so-called climbing bamboos, are slender scandent climbers, stretching over the crowns of tall forest trees. *Pseudostachyum polymorphum* (eastern Himalayas), *Melocanna bambusoides* (Chittagong), *Bambusa nutans* Wall. (Darjeeling) have a creeping habit. A few forms such as *Microbambus macrostachys* K. Schum. and *Atractocarpa olyriformis* Franch. (occurring in the Cameroons) are herbaceous.

Bamboos are characterised by woody pointed stems, commonly called culms, arising from their rhizomes, which are also woody. Generally, rhizomes are densely clustered so that culms grow in clumps. In a few cases, they grow at intervals from a long creeping rhizome (e.g. in *Melocanna*) or in tufts consisting of a small number of culms, as in *Phyllostachys* Sieb. & Zucc. Many bamboos flatten above the nodes, and this tendency is very marked in *Phyllostachys quadrangularis* Rendle, the Square bamboo of China (Arber, 70).

The growth of culms is very rapid, about 3″ per day, but may be even 15–16″ a day as in *Dendrocalamus giganteus*; and growth at this rate is continuous for about a month. A clump bears 30–100 culms. Every year at the beginning of the rainy season, about 10 large culms and 30–50 smaller ones shoot up.

The culms are generally round and smooth. They are usually hollow (the 'female bamboos'), and have transverse septa at the nodes. But the culms in *Dendrocalamus strictus*, *Arundinaria prainii*, *Oxytenanthera stocksii* are solid (the 'male bamboos'). When fully mature, some of them

attain a girth of a foot or more. The number of fibre bundles and the manner of their scattering add much to the hardness of the culm. The thickness of the outer shell and the deposit of silica in the outer cortical layers make them very hard. The culms are jointed at intervals and have prominent rings bearing sheaths characteristic of each species.

Ordinarily culms do not bear any branches for a considerable height above the base. But the culms of *Dendrocalamus hamiltonii*, *Oxytenanthera albociliata* have very large and prominent branches. *Bambusa arundinacea* and *B. tulda* also have branchlets, but they are arranged alternately in dense clusters. The lateral branches and the circle of false rootlets at the lower nodes of *B. arundinacea*, *B. blumeana* Schult. f. harden into spines and give a natural armour to clumps. The clumps gradually spread outwards forming new shoots on the periphery. Hence bamboos may be grown for soil reclamation in highly eroded areas.

Ordinarily young culms are not cut, while twisted culms and remnants of dead portions are carefully removed and the clumps are thinned every year. After the culms have reached maturity (5–6 years), they are generally cut from the stock, a few feet above the ground. Repeated cutting of culms, especially of young ones, impairs the vigour of clumps and hastens flowering and the ultimate extirpation of the whole clump. For purposes of exploitation, a plot is often divided into equiproductive blocks, preferably raised from different stocks, and worked in rotation.

The bamboos flower once during their life time and die out soon after. Flowering usually takes place at intervals of 25–50 years. But some species like *Schizostachyum elegantissimum* Kurz flower every third year, and a few flower annually, e.g., *Arundinaria wightiana*, *Bambusa lineata* Munro, *Ochlandra rheedii* Benth. A bamboo clump does not produce any additional culms for a year prior to flowering, which depends both upon the age of the clump and on climatic conditions. But the factors which lead to the phenomenon of general flowering are not yet clearly understood. A short rainy season followed by a spell of excessive hot weather is said to promote flowering.

In any area, almost all the clumps from a particular stock flower simultaneously. Consequently when a constant supply of bamboos is needed, clumps from different stocks of the same species, or different species are grown together, so that all of them do not flower at the same time. Bamboo flowers are green and inconspicuous. The seeds, which are produced profusely, are usually grains, except those of *Melocanna bambusoides* which are large and fleshy. In times of scarcity, bamboo seeds are used as food. Bamboo seeds germinate readily. During the first few years the plants look like grasses and are easily transplanted. Bamboos are, however, generally propagated by off-sets, cuttings and by layering.

DISEASES, INSECT PESTS, ETC.

Bamboos are known to suffer from fungal attacks. Nearly 31 species of higher fungi are reported to have been found both on felled, and on living bamboos (Banerjee and Ghose, *Sci. & Cult.*, 1942, **8**, 194). The most serious of these are: *Poria diversipora* B. & Br., *Guepinia spathularia* (Schw.) Fr., the hexagonal form of *Daedalea flavida* Lev., *Polyporus durus* Jungh., *Irpex flavus* Klotzsch, and *Nectria* spp. The last two are generally found on dead culms only.

Bamboos are prone to insect attacks and considerable damage is done by three borer beetles, *Dinoderus*, *Sinoxylon* and *Lyctus*, and bamboos attacked by these borers are useless for scaffolding and ladders (*vide* also Ramakrishna Ayyer, 376).

The resistance of culms to insect attacks largely depends upon the species, and on the age and maturity of culms. Some bamboos, e.g., *B. tulda*, *B. longispiculata* Gamble and *Dendrocalamus giganteus* are naturally very resistant. Young culms are susceptible to borers. But if the culms are allowed to grow for 5–6 years and are left standing with leaves in the vertical position, for about a week after they have been cut, they become more resistant. According to Trotter & Beeson (*Indian For.*, 1933, **59**, 709), bamboos should be felled when they are least liable to insect attack (Oct.–Dec. and June–July in the U.P., and Nov.–Dec. and May–June in the Punjab).

The quantity of sugar and other carbohydrates in culms has a definite relation to insect attacks. Also small amount of resin present in bamboos is said to attract borers (Boodle and Dallimore,

Kew Bull., 1920, 282). After cutting, bamboos are generally immersed in water for about three months, and dried before use. This eliminates soluble constituents, and makes them more insect-resistant.

Investigations have shown that internodal injection of preservatives is an effective method for the treatment of bamboos for protection against insect attacks, and two men can treat 600 running feet of bamboos per hour. The method consists in puncturing a ¼" hole through the wall of the internode near the septum, introducing about 20 c.c. of the preservative and then plugging the hole with putty. The culms are then stacked vertically, for 2–3 days, with the plugged holes uppermost. This method has now been adopted by Ordnance authorities. A mixture of creosote and fuel oil (1 : 1) is found to be the most effective preservative, and a mixture of creosote and rape oil (1 : 4) may be employed as a substitute. Superficial swabbing of culms with these creosote preservatives gives protection for about a year (Gardner, *Indian For. Bull., New Series*, No. 125, 1945). Aqueous solutions of boric acid, zinc chloride, or copper sulphate, were found ineffective.

Fires constitute the greatest danger to bamboo forests. These are often caused by the friction of culms, and by the accumulation of dry debris at their base. Heavy grazing is also injurious. Young foliage and shoots attract herds of deer, elephants, bisons, pigs and cattle. These eat away new shoots and impair the vitality and growth of the whole clump. Bamboo grains also attract animals and birds, especially rats.

USES

Deogun (*Indian For. Rec., New Series, Silv.*, 1937, **2**, 75) writes thus on the uses of bamboos : The strength of culms, their straightness, smoothness and lightness combined with hardness, their hollowness, the facility and regularity with which they can be split, and the range in size, make them suitable for a wide variety of purposes for which other materials would require much labour and preparation. To this must be added their abundance and the ease with which they can be propagated and cut, and the short period in which they attain maturity.

Bamboo is extensively used in place of timber, and frequently houses are made entirely out of the products of the plant. The framework is built up of suitable lengths, whilst floors, outer walls and inner partitions are made of split and flattened culms interwoven like matting. The framework of the roof may be of bamboos, and is thatched with straw or leaves. Bamboo is extensively used in constructional works for scaffolding and for making ladders, bridges, aqueducts, fences, supports, etc. It is used for a variety of purposes in all kinds of boats and rafts. Numerous articles of every day use are made out of bamboo : yokes, axles, tool-handles, cordage, beds, sticks, lathees, tent-poles, brushes, pipes, fans, umbrellas, toys, kites, musical instruments, spears, lance shafts, bows and arrows, torches and caps (from sheaths). Bamboo is the chief raw material for making baskets, and wicker-work, a cottage industry, usually carried on by a special caste. A number of articles, such as tiffin boxes, furniture, chicks, mats, etc. are produced, and large quantities of bamboo mats are exported for dunnage in ships. Bamboo work is sometimes reinforced with cane.

Selected sticks of thin varieties of bamboo (*Oxytenanthera monostigma, Pseudostachyum polymorphum*, etc.) are converted into umbrella handles by bending them over a heated iron rod of the desired shape (Dep. Industr., Bengal, Rep. Surv. Cottage Industr., Bengal, 1929, 100). Bamboo lacquer-ware is made on a small scale in Burma using bamboos of the species *Cephalostachyum pergracile* as frame and *thitsi* (the oleo-resin of *Melanorrhoea usitata*) as filling and varnishing material (*Indian For.*, 1933, **59**, 635). The Japanese tried bamboos for making aeroplane propellers (*Indian For.*, 1933, **59**, 380). During the war large quantities of bamboos have been used for military purposes such as air-raid covers for buildings (*Indian For.*, 1943, **69**, 330), containers, tent poles, and as substitute for timber in numerous constructions.

Bamboo seeds are extensively eaten by the poorer classes during famines, and there is a superstition which associates the gregarious flowering of bamboos with famines. Bamboo seeds generally resemble those of rice, but are somewhat bigger in size. The tender shoots are soaked in water, boiled, and used in curries, and for making pickles. The sap of these shoots has been found to contain hydrocyanic acid and to possess antiseptic and larvicidal properties (Murthy, *Indian med. Gaz.*, 1932, **67**, 617). If eaten raw, the shoots often prove poisonous. They contain a cyanogenetic

glucoside which on hydrolysis yields 0·03% of hydrocyanic acid, and about 0·23% benzoic acid. The sap contains about 0·03% of hydrocyanic acid and 0·16% of free benzoic acid (Ghosh, Ghosh and Chopra, *Arch. Pharm., Berl.*, 1938, **276**, 351).

Sometimes, flowering culms in dry localities exude a sweet, white, brittle gum which is edible. This consists mostly of saccharine matter (Hooper, *Agric. Ledger*, 1900, **7**, 185). The gummy manna found on bamboos in Java is reported to be largely melitose or melozitose (Von Lippmann, *Chem. Abstr.*, 1927, **21**, 1291). Water in the hollow internodes is used for medicinal purposes, and the hair on the spathes as poison.

Tabasheer or *banslochan* is a siliceous secretion found in the culms of various species of bamboos. It occurs in fragments or masses, about an inch thick. It is the residue of the watery liquid occasionally found in hollow internodes. Its presence is generally detected by a rattling noise on shaking the bamboo.

Tabasheer may be chalky, translucent or transparent (sp. gr., 2·16–2·19, and n_D, 1·115–1·1503). It is usually of the colour of pumice, and sometimes it is also bluish white. It has no taste. It is mainly composed of silicic acid (SiO_2, up to 96·9%) with about 1% of organic matter. The residue obtained on ignition contains 99% of silica with traces of iron, calcium, alum and alkalies (Wehmer, I, 103). Tabasheer has enjoyed considerable reputation in medicine in the East. It is used as a cooling tonic and aphrodisiac, and in asthma, cough, and other debilitating diseases (Chopra, 568).

Bamboo leaves are much valued as fodder, particularly when there is scarcity of pasture. Cattle and horses relish it. In some districts, bamboo foliage forms the favourite food of elephants.

As a living plant bamboo is used for defence works, for hedges, and in landscape gardening. It is a valuable plant for wind-breaks and is particularly useful for preventing soil erosion on account of its interwoven root system.

PAPER-PULP FROM BAMBOOS

(Bhargava, *Indian For. Bull., New Series, Util.*, No. 129, 1946, i–iii)

Although bamboo has been used from very ancient times in China for making paper, the large scale manufacture of bamboo paper is a comparatively recent development. Routledge published two pamphlets in 1875 and 1879 describing the preparation of paper-pulp from soft, undeveloped young culms of 4–6 months' growth. Sindall proved the possibility of preparing high class papers from bamboos after the removal of nodes (Sindall, Bamboo for Papermaking, 1909). But the successful utilization of bamboos for papermaking in India is mostly due to investigations of Raitt (*Indian For. Rec.*, 1912, **3**, iii). Bamboo pulp began to be manufactured in 1923, and today bamboo forms the most important raw material for the Indian paper industry. Since 1924 a pilot plant installed at the Forest Research Institute, Dehra Dun, has been studying several problems connected with the industry.

The following are the species reported to be available in large quantities: *Bambusa arundinacea, B. polymorpha, B. tulda, Dendrocalamus hamiltonii, D. longispathus, D. strictus, Melocanna bambusoides, Neohouzeaua dullooa* (syn. *Teinostachyum dullooa*), *Ochlandra travancorica*, and *Oxytenanthera nigrociliata*. But, at present, only *Dendrocalamus strictus, Melocanna bambusoides*, and to a limited extent, *Bambusa arundinacea* and *Ochlandra travancorica* (*eta*) are being exploited for paper-pulp manufacture (Deogun, *loc. cit.*). Of these, *Dendrocalamus strictus* and *Bambusa arundinacea* are fairly widely distributed, while *Melocanna bambusoides* is restricted to Chittagong and Arakan Hills and some districts of Burma, and *Ochlandra travancorica*, to Tinnevelly dist. and Travancore (*vide* Pl. XXIII,1–3).

Raitt, who investigated five species of bamboos (*B. arundinacea, B. tulda, B. polymorpha, Cephalostachyum pergracile* and *Melocanna bambusoides*), found that the first three could be mixed for the preparation of paper-pulp. Recent experiments at the Forest Research Institute have shown that *Bambusa tulda, Dendrocalamus longispathus, Neohouzeaua dullooa* and *Oxytenanthera auriculata* can be satisfactorily digested together for production of paper-pulp. For paper manufacture, supplies of bamboo when mixed may be taken to be more or less uniform in character and composition. In this respect, bamboo can be compared to spruce wood in which springwood and summerwood do not show marked differences in chemical composition.

For proper forest exploitation, and for obtaining maximum yield of cellulose, only mature culms

2–3 years old are used for pulp manufacture. Before use they are generally seasoned in open yards for 6–12 months, when their moisture content falls to 9–11%.

Table I gives the average measurements of bamboos of 2–3 years old (Sindall, *loc. cit.*, 56). Air-dry bamboos, on an average yield about 40% of bleached pulp, and hence approximately 2·4 tons of bamboos are required for the manufacture of one ton of pulp. Although bamboo pulp is less strong and durable, bamboo presents several advantages over *sabai* or *bhabar* grass (*Eulaliopsis binata*, syn. *Ischaemum angustifolium*) as raw material for the manufacture of paper in India. Bamboo grows in dense culms, while *sabai* grass is found in scattered tufts; the cost of collection is much less, and the yield per acre much larger. Where water transport is available, bamboos can be floated down in rafts, thus reducing the cost of transport. Also, yield of unbleached pulp from bamboo is slightly higher (43%) than from *sabai* grass (40%).

TABLE I

	Average diameter in inches	Weight in lb. of air-dried stems, 20′ long	20′ stems required for one ton of air-dried bamboo
Large bamboos . .	2·5	11·5	195
Small bamboos . .	1·5	7·0	320

The preparation of paper pulp consists essentially in the separation of cellulose fibres from other components such as lignins, starches, fats and resins, which are usually found in the raw materials. This is effected by reducing them to smaller size and digesting them under suitable conditions of temperature and pressure, with chemicals, such as sulphites or alkalis.

Bamboo presents several features which markedly differentiate it from the other raw materials used for paper manufacture. The structural elements of the stem—parenchymatous cells, fibres, fibro-vascular bundles—all lie longitudinally in close juxtaposition with one another with very few air-cavities between them (Pl. XXIII, 4). A dead bamboo stem contains about 58% of air (by volume), while most woods contain 66%, and hence, bamboo offers greater resistance to the penetration of digestion liquors.

Chemically the stem consists almost entirely of cellulose and hemicelluloses (xylans, arabans polyuronides, etc.) and lignins, with a small amount of fats, resins, etc. (Table II).

Bamboos come intermediate between grasses and coniferous woods. Grasses are richer in pectose, and coniferous woods, in lignin (Table III).

Further, the nodes in bamboo, which constitute 6–15% by weight of the culm in different species, are large and hard, and require more vigorous treatment. Variations are also observed in their composition; the nodes contain a larger amount of pectose than the internodes, but their lignin content is only slightly higher (Table IV).

TABLE II

CHEMICAL COMPOSITION OF BAMBOOS*

(Per cent. of oven-dried bamboos)

Species	Ash	Silica	Hot water solubles	Pentosans	Lignin	Cellulose
Bambusa arundinacea	3·3	1·8	6·0	19·6	30·1	57·6
Dendrocalamus strictus	2·1	0·8	5·9	19·6	32·2	60·8
Melocanna bambusoides	1·9	1·5	6·5	15·1	24·1	62·3
Ochlandra travancorica	2·6	2·1	5·1	17·8	26·9	61·8

*Bhargava, *loc. cit.*

TABLE III

ANALYSIS OF RAW MATERIALS FOR PAPER-PULP*

(Per cent.)

	Water extract	Fat, wax, etc.	Pect-ose	Lignin	Cellu-lose	Ash
Bambusa arundinacea (2 yrs.)	8·5	1·2	24·4	15·6	50·3	1·6
Melocanna bambusoides (2 yrs.)	13·6	1·7	12·8	21·7	51·2	2·3
Sabai grass (cut before flowering)	9·1	2·6	35·6	3·4	49·3	6·2
Spruce wood	6·7	3·0	0·0	35·8	54·5	0·1

*Raitt, *loc. cit.*

TABLE IV

ANALYSIS OF INTERNODES AND NODES IN SEASONED BAMBOOS*

(Per cent.)

	Water extract	Fat & wax	Pect-ose	Lignin	Cellu-lose	Ash
B. polymorpha (Internodes, 91%)	8·7	1·0	19·2	15·3	55·8	3·9
(Nodes, 9%)	9·8	1·4	25·0	17·6	46·1	4·5
" " Average for the entire culm	8·8	1·1	19·7	15·5	35·0	5·9
O. pergracile (Internodes, 94%)	8·0	0·9	22·1	15·1	53·9	2·5
(Nodes, 6%)	9·1	1·2	26·3	16·7	46·7	4·2
" " Average for the entire culm.	8·0	0·9	22·4	15·2	53·5	2·6

*Raitt, *loc. cit.*

Raitt solved the difficulties due to the physical structure of bamboos by thoroughly crushing the culms prior to digestion. A uniform and thorough digestion of the material is rendered practicable and the nodes no longer present any special resistance.

The commonly used commercial processes for the digestion of raw materials are: the 'sulphite process', using an aqueous solution of calcium or magnesium bisulphite, with a small concentration of free sulphur dioxide; the 'soda process' using sodium hydroxide; and the 'sulphate process', which employs a mixture of sodium hydroxide and sodium sulphide, the latter being derived from sodium sulphate.

Chemical wood pulp is mostly prepared by the sulphite process. In India, it does not appear to be well-suited to the production of pulp from bamboos. The Indian Paper Pulp Company, Naihati (Bengal), is the only concern making sulphite pulp (6,000 tons per annum) from bamboos, using magnesium bisulphite liquor.

The active agent in the soda and the sulphate processes is sodium hydroxide, and the sulphate process is generally preferred. The liquor used for digestion consists initially of a solution of caustic soda and sodium sulphate. After digestion, the spent liquor is evaporated and the residue incinerated, when the sulphate is converted into the sulphide by the organic matter present. The resulting ash is dissolved in water, causticized by lime and used again. The loss in strength of alkali is made up by the addition of fresh sulphate and some free alkali.

Owing to the presence of a high proportion of hemicelluloses in bamboos, which on degradation react with alkali, it is necessary to use higher concentrations of alkali and to carry out the

digestion at more elevated temperatures and for longer periods. This results in partial degradation of cellulose with a consequent lower yield, and the pulp obtained is dark-coloured and difficult to bleach. The products formed in the earlier stages of digestion turn into dark-coloured compounds and are absorbed by the fibres of the pulp during the delignification stage.

Raitt developed the fractional method of digestion as a solution to this problem. In the first stage, comparatively mild conditions are employed sufficient to bring into solution those constituents of bamboo which are easily acted upon by dilute alkali (NaOH, 10% of the air-dry wt. of bamboo ; conc., 2% ; 110°–120° ; 2–2½ hrs.). The dark-coloured compounds are removed at this stage and do not get a chance of being absorbed by the fibres of the pulp. In the second stage, the material is digested under more drastic conditons with stronger alkali (NaOH, 18% of the air-dry wt. of bamboo ; conc., 6–7% ; 140°–160° ; 2–3 hrs.), in order to remove lignin. This fractional method results in a saving of alkali, and also in a higher yield of pulp which can be easily bleached to a good white shade, and is now generally adopted in most Indian factories. The same principle is adopted in the 'cascade process' in which two or more digestions are given to each charge of bamboos, using the counterflow principle, in a battery of digesters (Titaghur Paper Mills, Cascade Process of Bamboo Digestion).

TABLE V

SEMI-COMMERCIAL PULPING TESTS ON BAMBOOS*

(Two stage digestion according to Raitt)

Species	Unbleached pulp	Bleached pulp	Fibre length (mm.)		
	(Per cent. of air-dried	bamboos)	Max.	Min.	Av.
Bambusa arundinacea	42·6	39·0	4·05	0·67	2·73
Dendrocalamus strictus	43·6	40·1	5·5	1·0	3·06
Melocanna bambusoides	45·9	41·8	4·75	1·0	2·72
Ochlandra travancorica	48·3	45·8	9·0	1·0	4·03

*Bhargava, *loc. cit.*

Bamboo pulp is suitable for preparing better grades of printing-paper. Paper prepared from bamboo pulp compares favourably with ordinary supercalendered and printing-paper. It is capable of standing considerable wear and tear, and retains its whiteness and brilliance for reasonably long periods.

Papers containing pure bamboo pulp have been made without any difficulty. Generally bamboo pulp is used along with rag pulp, grass pulp or chemical pulp. Papers prepared from such mixtures are reported to have superior opacity. The normal bamboo pulp content of Indian papers is about 60% (Mysore Paper Mills Co., 1946).

Kraft pulp from bamboos is obtained by single stage digestion with a smaller proportion of alkali (Bhargava and Singh, *Indian For. Bull., New Series, Util.*, No. 112, 1942). The paper produced compares favourably in strength with imported varieties. The Orient Paper Mills in Orissa specialize in the production of kraft paper and are capable of producing 8,000–9,000 tons annually.

Bamboo is not suited to the production of mechanical pulp. Mechanical pulp has been produced from *Bambusa nutans*, *B. tulda* and *Dendrocalamus strictus*. Papers from a mixture of 70% of such mechanical pulp and 30% of ordinary pulp were weak in strength and unsatisfactory. However, since bamboo pulp, suitable for the preparation of high class paper can be readily manufactured, it would not be economical to use it for cheaper grades.

The possibilities of using bamboos for the production of rayon pulp are under investigation. Wood pulp suitable for rayon manufacture is made by the sulphite process and contains 89·1–90·6% α-cellulose and 0·09–0·13% ash, while bleached bamboo pulp for paper manufacture usually contains 85% α-cellulose and 1–1·25% ash. Thus it has a lower α-cellulose content and a higher ash content, and is besides mostly manufactured by the alkali process (Table VI). *Ochlandra travancorica* of Travancore, reported to yield pulp of superior quality, offers possibilities for use in rayon manufacture (Thoria, *Indian Text. J.*, 1947, **57**, 536).

PRODUCTION

The production of bamboo pulp increased from about 1,700 tons (5,000 tons of bamboos) in 1925

TABLE VI

α-CELLULOSE CONTENT OF BAMBOO PULPS*

(Per cent.)

	Dry Raw material			Pulp	
	α-Cellulose	Ash	Yield of pulp	α-Cellulose	Ash
Bambusa arundinacea .	28·2 34·0	2·3	34·1-42·4	79·9–86·9	0·5–1·1
Dendrocalamus strictus .	29·2–39·2	3·8 5·6	37·2–45·5	78·8 86·5	0·8 3·1
Ochlandra travancorica	33·5-35·9	5·0	37·6 42·8	83·5 92·7	0·4 1·3

*Nazir Ahmed and Karnik, *J. sci. industr. Res.*, 1943-44, **2**, 276.

to 5,000 tons in 1932 when a protective duty of Rs. 45 per ton was imposed on imported pulp. This resulted in rapid expansion of the industry and production of bamboo pulp advanced to over 19,000 tons in '36-37, and was nearly 33,000 tons just before the War ('39-45), and the protective duty was reduced to a minimum of Rs. 30 per ton in 1939. Since the beginning of the War, owing to the stoppage of imports, India has been obliged to depend upon her own resources of raw materials for paper-pulp, and this resulted in a phenomenal increase in production. In '44-45, nearly 62,300 tons of bamboo pulp were manufactured. It is of interest to note that while the proportion of bamboo pulp to that of grass pulp produced in India was 3 : 2 just before the War, it became 6 : 2 in '44-45. The production of the latter has remained stationary, and that of the former has risen to nearly twice the pre-war output. The present demand for bamboos for the maximum output of existing paper factories in India amounts to about 210,000 tons per annum.

The cost of bamboo delivered at factories depends upon several factors, such as the distance of the factory from bamboo forests, the method of transport, and concessions. In 1931, the price varied from Rs. 27 to Rs. 40 per ton, and on an average, the cost per ton of air-dried bamboo for forest-centred mills was Rs. 30, and for market-centred mills, Rs. 40. This had gradually fallen to Rs. 15 17, and even Rs. 12 per ton before the War. The present cost is reported to be Rs. 60 or more per ton.

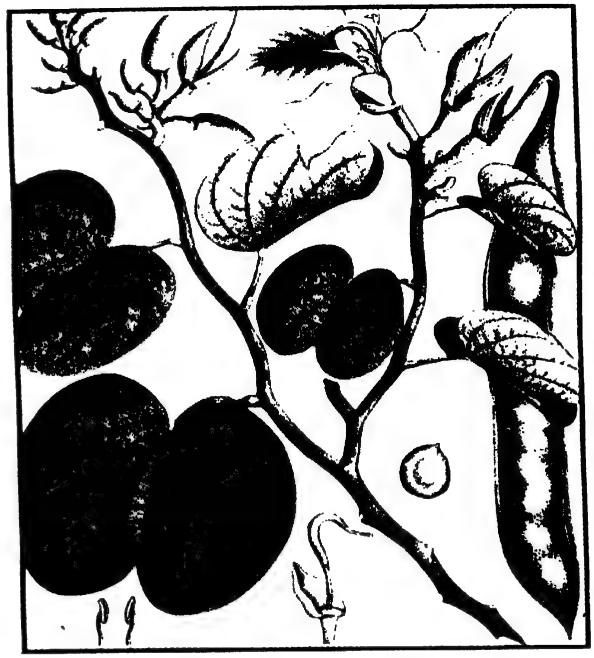
Bamboo forests of moderate size are found in U.P. (Landsdowne, Kalagarh, Saharanpur, Jhansi and Banda divisions) and in Bhopal (near Budhni Railway Station).

In Burma, Arakan, Tenasserim, and Tavoy and Mergui regions, yield annually 700,300, 307,000 and 654,000 tons respectively of bamboo (Indian Tariff Bd., Rep. Paper and Paper-pulp Industr., 1931, 42).

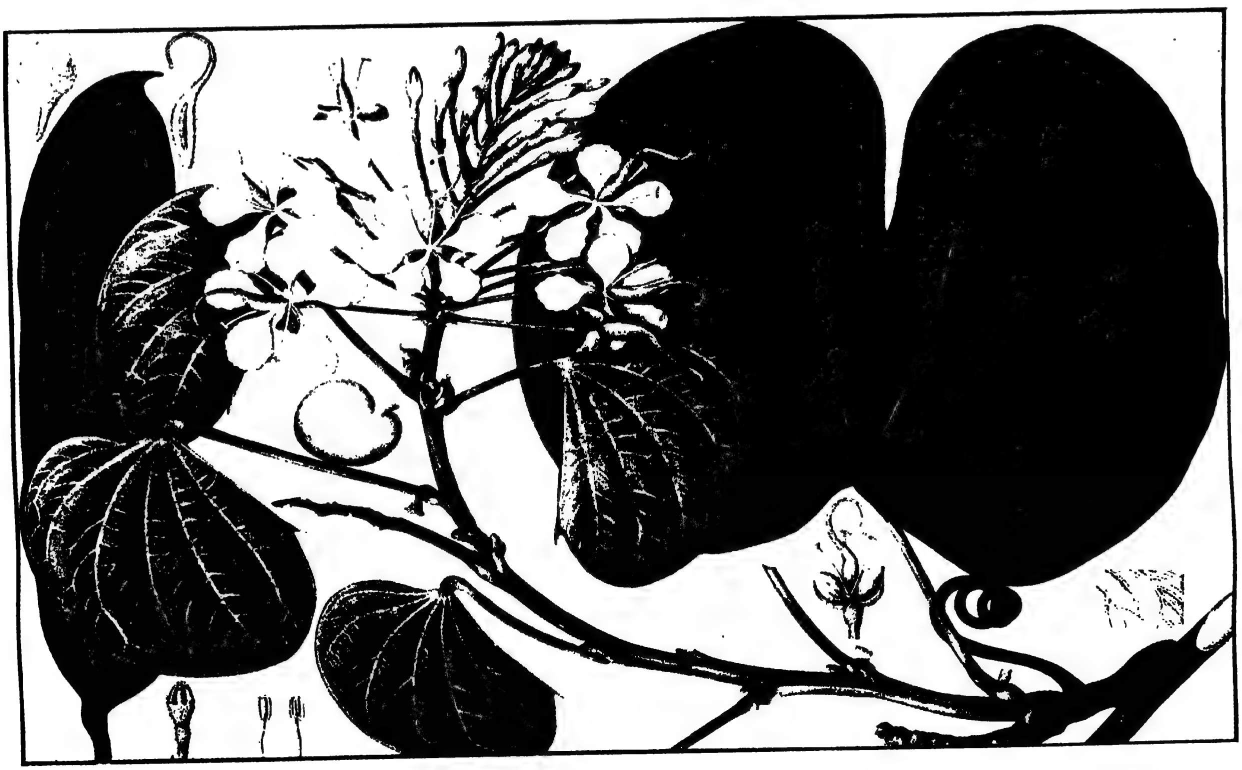
During 1925-26 to 1929-30, bamboos used to bring in a more or less steady revenue of over Rs. 18 lakhs per annum, and in recent years ('33-34 to '43-44) about Rs. 15 lakhs per annum (*Return Statist. For. Adm. Br. India*). These figures refer to British India only, and several Indian States also have large areas covered with bamboo. The revenue is by no means the maximum that the bamboo forests in British India could yield. Thousands of acres have never been worked, and thousands remain unworked every year. Even in those areas which are worked, millions of bamboos are left to rot. The population resident near bamboo forests is allowed bamboo for domestic use free or at nominal rates (Deogun, *Indian For. Rec., New Series, Silv.*, 1940, **2**, No. 4).

It is not possible to estimate either the total quantity of bamboos cut, or their value, because of the practice of auctioning coops. Exploitation has been very severe during the War, on account of heavy demand for military purposes and consequent high prices. It is estimated that in '44-45, the Government purchased bamboos worth nearly Rs. 1·9 crores.

1. BARLERIA PRIONITIS



2. BAUHINIA VARIEGATA



3. BAUHINIA VAHLII

TABLE VII

THE BAMBOO RESOURCES OF INDIA*

Province or State	Division	Predominant species	Acreage	Annual supplies (Tons)
Assam	Cachar, Sylhet	*Melocanna bambusoides*, etc.	113,000 (Sylhet only)	30,900
Bengal	Chittagong Hill Tracts, Kasalong Reserve	do.	..	100,000
Bombay	Dangs (Surat)	*Dendrocalamus strictus*	..	10,000
	Kanara	do.	..	145,700
Bihar	Palamau	do.	121,600	9,000
Central Provinces	Raipur, Balaghat, Chanda, Nagpur, Wardha, Seoni, Bhandara, Melghat, Niman, Betul, Bilaspur and Saugor.	do.	1,158,976	27,545
Madras	Reckapalli hills (Upper Godavari),	do.	43,430	20,957
	Papi Konda Reserve (Lower Godavari),	do.	..	5,710
	Ramapuram Range (Kollegal),	do.	25,000	17,000
	Papanasam forests (Tinnevelly)	*Ochlandra travancorica*	20,000	25,000
Orissa	Sambalpur	*Dendrocalamus strictus*	65,988	26,154
	Barpahar	do.	116,292	24,271
	Angul	do.	160,361	18,000
	Puri	*Bambusa arundinacea*	42,656	..
	Ganjam	*Dendrocalamus strictus*	23,000	3,000
Hyderabad		do.	..	25,000
Travancore		*Ochlandra travancorica*	..	25,000
Mysore §		*Bambusa arundinacea*	..	50,000
		Dendrocalamus strictus	..	50,000

* Indian Tariff Bd. Written & Oral Evidence, Paper and Paper-pulp Industr., 1939, 176; *vide* also Pearson, *Indian For. Rec.*, 1912, **4**, v; § Indian Tariff Bd., Rep. Paper & Paper-pulp Industr., 1938, 11.

BAMBUSA Schreb. GRAMINEAE

A genus of 70 spp. of bamboos, distributed in eastern Asia, Africa and America. The species have underground rhizomes giving rise to tall hollow culms. These are usually clumpy and bear large leafless paniculate inflorescences. 26 species occur in India, mostly at 3000–7000′, but a few such as *B. balcooa*, are restricted to the plains.

These are tall bamboos, usually 40–60′ in height. *B. brandisii* Munro reaches a height of 125′ or even more. But *B. nana* Roxb. is hardly 6–10′ in height and it makes good hedges. The culms of these bamboos are generally smooth, but those of *B. arundinacea* and *B. spinosa* Roxb. are spiny.

B. arundinacea Willd. THE THORNY BAMBOO

D. E. P., I, 390; Gamble, *Ann. R. bot. Gdn Calcutta*, 1896, **7**, 51, Pl. 48; & Pl. XXIII, 1.

SANS.—*Vansh*; HIND., MAR. & GUJ.—*Bans*; BENG.—*Ketua, kutuasi*; TEL.—*Bongu-veduru, pente-veduru*; TAM. & MAL.—*Mungil*; KAN.—*Biduru*; ASSAM—*Kotoha*; BURMA—*Kyakatwa*.

A tall, thorny bamboo, with a thick central root-stock, bearing bright green shining culms, 80–100′ high and up to 6–7″ in diameter. It generally flowers gregariously, once in about 30 years. The clumps then die out, after producing an abundant crop of grains.

The species is wild throughout the greater part of the country, especially in the hill forests of western and southern India, ascending up to 3000′ on the Nilgiris. It occurs in the warmer parts of Ceylon and Burma, and is wild on the Pegu and the Martaban hills. It is also grown in other parts of India. The species grows rapidly (about 1′ 8″ per day).

This bamboo makes a close, almost impenetrable hedge, on account of its interlacing thorny branchlets. Its crooked and knotty culms render it a second class bamboo, its chief use being for floating heavy timber and for structural purposes. Split culms are used for mat-making basket work, etc.

It yields paper pulp of good quality. Tabasher occurs in the hollows of its culms. Its grains are eaten during famines. The husked grain contains: water, 11·0; starch, 73·7; albuminoids, 11·8; oil, 0·6; fibre, 1·7; and ash, 1·2% (Lisboa, 138). Young shoots are pickled or made into curries. Its leaves and twigs are used as fodder and are largely consumed by elephants and cattle.

The young shoots contain a cyanogenetic glucoside and are poisonous. The glucoside is hydrolysed by an enzyme, also present in the shoots, when they are cut into pieces and soaked in water (Bagchi and Ganguli, *Indian med. Gaz.*, 1943, **78**, 41). One quarter of an ounce of raw shoots or a slightly larger amount of insufficiently cooked shoots can cause death. The young shoots contain 0·03% of HCN (Ghose, Ghose & Chopra, *Arch. Pharm., Berl.*, 1938, **276**, 351) and are lethal to mosquito larvæ (Chopra, Badhawar & Nayar, *J. Bombay nat. Hist. Soc.*, 1941, **42**, 865).

Attempts have been made to obtain crosses with sugarcane at the Coimbatore Sugarcane Experimental Station (Venkataraman, *Indian For.*, 1939, **65**, 106; *vide Saccharum officinarum*).

The leaves are reported to be given to horses as a remedy for coughs and colds.

B. balcooa Roxb.

D. E. P., I, 391; Gamble, *loc. cit.*, 40, Pl. 38.

BENG.—*Baluka*; ASSAM—*Bhaluka*.

A tall bamboo with long dull, greyish green culms, 50–70′ high, and 3·1–6·7″ in diameter, occurring in Assam, Bengal and Bihar.

When seasoned by immersion in water, it becomes very durable and insect-resistant. It is the best Bengal species for building purposes.

B. polymorpha Munro

D. E. P., I, 392; Gamble, *loc. cit.*, 36, Pl. 34.

BENG.—*Jama betua*; ASSAM—*Betua*.

A large evergreen bamboo, with grey to greyish-green culms, 50–80′ high, 3·4–6·7″ in diameter, occurring in the mixed forests of east Bengal, Assam and Burma. In Burma, it is a popular bamboo for roofing and flooring.

B. tulda Roxb.

D. E. P., I, 393; Gamble, *loc. cit.*, 30, Pl. 29.

HIND.—*Peka*; BENG.—*Tulda*; SANTAL—*Mak*.

An evergreen or deciduous, gregarious bamboo, with green or greyish-green culms, 20–70′ high, and 2·2–4·4″ in diameter, very common in Assam, Bengal and in the hill forests of Northern Circars. It extends eastwards to Burma.

This is one of the most useful bamboos. It is seasoned by immersing it in water, when it becomes insect-resistant. It is largely used in constructions, mat-making, basket-work, etc. The young shoots are pickled and eaten.

B. tulda from the U. S. A. was found to yield 46·0% of unbleached pulp, or 43·6% of bleached pulp containing α-93·6% cellulose. It is suitable for the manufacture of good quality paper and also rayon (Lan, *Chem. Abstr.*, 1941, **35**, 6444).

B. vulgaris Schrad. THE GOLDEN BAMBOO

D. E. P., I, 394; Gamble, *loc. cit.*, 43, Pl. 40.

BENG.—*Basini bans*; MAR.—*Kalaka*; TAM.—*Ponmungil*.

A moderate-sized bamboo, 20–50′ high, and 2·2–4·4″ in diameter, with yellow or green-striped culms, growing separate from one another. It occurs wild in the warmer parts of India, Burma, Ceylon and Malaya. In Ceylon, it is a valuable species much used for scaffolding, roofing, etc.

B. vulgaris var. *striata* Gamble is an ornamental variety.

Banana, see **Musa**

Banyan, see **Ficus benghalensis**

Baobab, see **Adansonia digitata**

Barbados Pride, see **Caesalpinia pulcherrima**

Barberries, see **Berberis**

BARIUM MINERALS

Barium occurs in nature mostly as barite (sulphate) or witherite (carbonate), and occasionally in small amounts as an impurity, or as a replacing element in a few silicates, manganese-bearing minerals, felspar, etc.

Barite or barytes (BaO, 65·7% ; sp. gr., 4·3–4·6 ; H., 3) is popularly known as heavy spar. In the Ceded Dists. it is called *muggu rayi* (Telugu), because the powdered mineral is used to draw patterns on the floors and thresholds of Hindu houses in southern India. Barite is heavier than most non-metallic minerals, and its medium refractive index is 1·638. It crystallizes in orthorhombic system and may assume massive, granular, columnar, stalactitic or clustered forms. The colour is generally white, grey or yellow, but occasionally perfectly transparent and optically clear pieces have been obtained.

Witherite (BaO, 77·7% ; sp. gr., 4·3 ; H., 3·5) also crystallizes in orthorhombic system and occurs in massive, granular and columnar forms. No deposits of this mineral have been found in India.

Barite occurs generally as veins filling fault planes, joint planes and fissures, or as a replacement of country rocks. It may also occur as a residual material derived from rocks containing it. It is not uncommonly found as a gangue mineral associated with quartz in metalliferous veins. Fairly thick veins and lenses are formed as a result of replacement of limestones and dolomites. By far the most important occurrences are veins of hydrothermal origin, but it is possible that some veins may have been formed by meteoric (surface) waters.

DISTRIBUTION

(Coulson, *Mem. geol. Surv. India*, 1934, **64**, Pt. I)

In India, the principal workable deposits of barite occur in the Ceded Dists. (Madras), and in Rajputana.

Baluchistan : Occurrences of barite are known in several places in Kalat and Las Bela States in Cretaceous and Eocene strata.

Bihar and Eastern States : Some veins associated with galena are found to run east-west through Silwai (23°23′ : 85°27′), Bahea (23°23′ : 85°30′) and Bongaibera (23°3′ : 85°31′), some 14 miles east of Ranchi, in Ranchi dist.

Replacement veins are found along two parallel zones dipping steeply to the south-east, half a mile south-west of Kolpotka (22°22′ : 85°6′) near Saraikela station on the Bengal Nagpur Railway in Singhbhum dist. The southern zone contains ramifying veins in an area 500 yards × 150 yards. The veins were worked in '27–28 producing about 2 tons per day. The northern zone was too poor to be worked profitably.

A vein of barite was discovered and opened up in 1931, a little to the east of Khatangtola (22°22′ : 85°4′) near the eastern border of Gangpur State. The vein was 3′ thick, in mica-schists striking NW.-SE. for over 100′. An occurrence has been recorded in the village of Malthole (23°26′ : 86°26′) in the Panchkot Raj Estate in Manbhum dist. The mineral is said to be associated with silicate minerals of rare earths.

Burma : Workable deposits of barite occur in the Northern Shan States, Amherst, Mandalay and Kyaukse dists. The Azintaung hill, 15 miles south of Mitan (16°0′ : 98°24′) in Amherst dist. shows numerous veins in limestone. Other deposits occur in the neighbourhood, in the Ooteetaung on the Thailand border, and in the Yethewa, Tichine and Tilloun areas in the south-central part of the same district.

A 7′ thick vein of barite occurs at Taunggaung in Mandalay dist. Another vein is found in the Plateau Limestone south of Loi Kyaktaw. At Bawdwin, in Tawng Peng State, four nearly parallel veins are present, with the width varying between 1′ and 3′. The country rock at the side contained some disseminated material. The mineral was massive and the deposits were estimated by the Burma Corporation Ltd., to be able to yield 20,000 tons of barite.

In the Southern Shan States, barite is fairly common near Mawson (20°57′ : 96°47′) where it is usually found as veins associated with quartz.

Central India : Barite associated with an equal amount of quartz occurs in a vein in Bundelkhand gneiss near Surajpura village (24°44′ : 79°11′) close to the Chakrata hill, about 40 miles from Man Ranipur on the G.I.P. Railway. The vein is over 2 furlongs and sometimes more than 8′ thick. It has been estimated that about 12,000 tons of barite can easily be won from this deposit up to a depth of 10′ (Dubey, *Trans. Indian ceram. Soc.*, 1942, **1**, 108). A few other veins are also noted in the neighbouring village of Nygaon. These occurrences are in Orchha State.

Central Provinces: Barite is found as a minor constituent of copper-bearing veins of Sleemanabad (23°38′ : 80°15′) in Jubbulpore dist., striking NNW. in Archaean dolomitic limestones. Some 16 tons of this mineral are said to have been tried in paint works in Calcutta in 1904. In 1939, there was a production of 212 tons of barite from Jubbulpore dist.

A workable fissure vein and several lenticular, pockets of barite occur in dolomitic country rocks near Bhatagaon village, about 7 miles NE. of Newar railway station in Jubbulpore dist. It is estimated that the deposit can yield from its exposures about 50,000 tons of barite (Deb, *Calcutta Geogr. Rev.*, 1942, **4**, 172).

Kashmir: Thin veins of barite traverse the Great Limestone formation of Riasi dist., especially near Jangalgali Pass, and Kheri Kot. The mineral is locally called *chitta surma*.

Madras: In Cuddapah dist. (Pl. XXV, 1), veins up to 3′ in thickness are known to occur in several places 2½–4 miles south-west of Mittamidapalle (14°26′ : 78°44′). Within a two-mile radius of Chimalpenta (14°26′ : 78°36′) several deposits are present in the Tummaluru reserved forest. A few good occurrences are known around Uppalapalle (14°26′ : 78°32′), and also about ½ mile north-west of Rajupalem (14°26′ : 78°31′).

Several deposits occur near Karnapapayapalle (14°32′ : 78°5′), Ippatla (14°26′ : 78°11′), Midipenta (14°20′ : 78°19′), Kottapalle (14°22′ : 78°22′) and Nandipalle (14°23′ : 78°25′). Most of the occurrences are fissure fillings in dolomitic limestones or traps intrusive into them. The Kottapalle occurrences are important as some veins are over 1·5 miles long.

The chief deposits of Anantapur dist. are near Nerijamupalle (14°33′: 78°1′), Madugupalle (14°43′: 77°54′), Dosaledu (14°47′ : 77·55′), Mutssukota (14°51′ : 77°53′) and Chandana (15°5′ : 77°49′), all in Tadpatri taluk. A vein in the first locality was opened up in a few places, showing that it is over 200 yards long and 4′ thick. The best deposit at Mutssukota is situated a mile and three quarters WSW. of the village, the vein being over 100 yards long and up to 30′ wide. Other deposits occur in this district at Venkatampalle (14°48′: 77°50′) in Anantpur taluk, Krishtipadu (15°4′: 77°47′) in Gooty taluk, and Mudigubba (14°21′ : 77°59′) in Kadiri taluk.

There are numerous occurrences of barite in Kurnool dist., the most important ones being in Dhone taluk. Those in the neighbourhood of Balapalapalle (15°28′ : 78°7′) are the best known and the most productive. Others worth mentioning are near Hussainpuram (15°14′ : 77°50′), Ramapuram (15°17′ : 77°52′), Valasala (15°24′ : 77°59′), Rahimanpuram (15°24′ : 78°3′), Gattimanikonda (15°32′ : 78°11′) and Janapalacheruvu (15°28′ : 79°9′).

An interesting occurrence is near Alangayam (12°37′ : 78°45′) in North Arcot dist. The two low hills south of the village consist largely of a network of veins of a mixture of barite and quartz traversing porphyritic gneiss. Some of the veins have been traced to a length of some 7 miles. They vary in thickness from mere stringers to dyke-like masses several feet across. The proportion of the mineral in the rock is said to be about 30%.

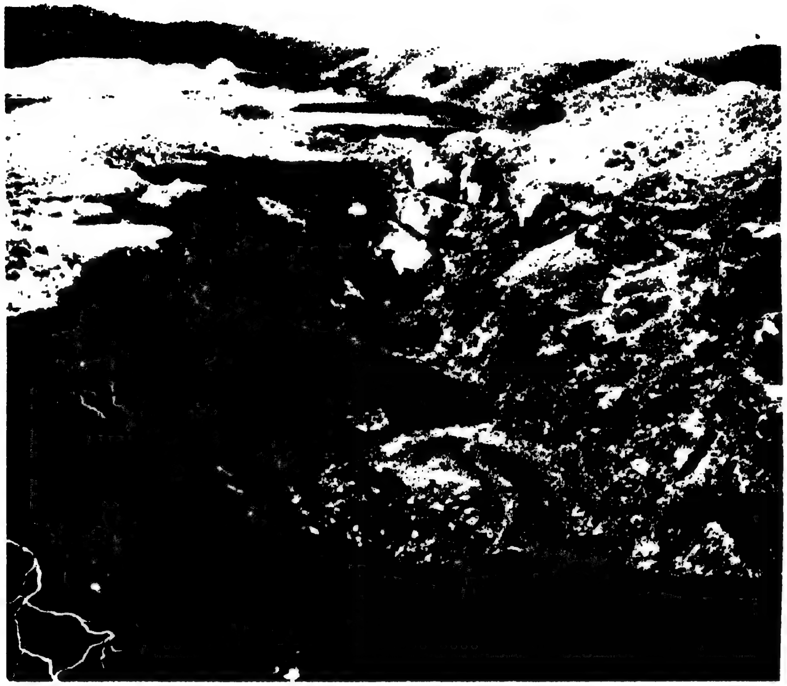
Punjab States: A discontinuous vein of barite occurs in the Simla hills (30°59′ : 77°1′) two miles ESE. of Subathu. The vein is about 4′ thick and occurs along a fault zone for a length of about a mile.

Rajputana: Several deposits occur in Alwar State (Roy, *Rec. geol. Surv. India*, 1922, **54**, 238). The chief localities are Bhakhera (27°32′ : 76 36′) about 2½ miles south of Alwar city; Jamrauli (27°9′ : 76°40′), 7 miles SSE. of Rajgarh railway station; Sainpuri (27°44′ : 76°38′) about 3½ miles N. by E. of Parisal railway station. The barite occurs as veins traversing the Alwar quartzites of the Delhi system. The Sainpuri vein is the most important, being over 110′ long and 15′ thick. In 1936, there was production of 40 tons of barite from Jaipur State.

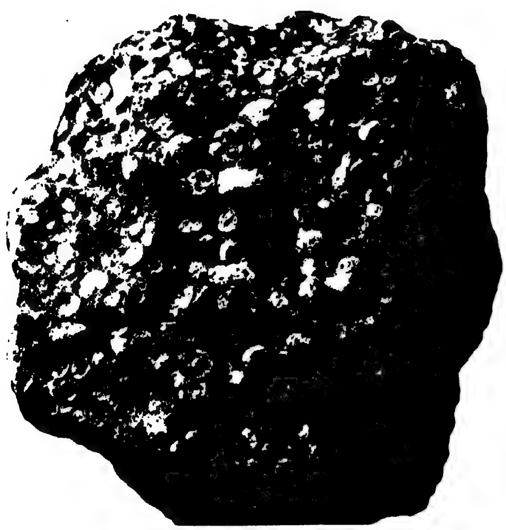
MINING AND PREPARATION

Veins of barite are generally irregular, the length and downward extension being much greater than their thickness. If the veins happen to follow bedding planes or joint planes, they are more regular and tabular in shape.

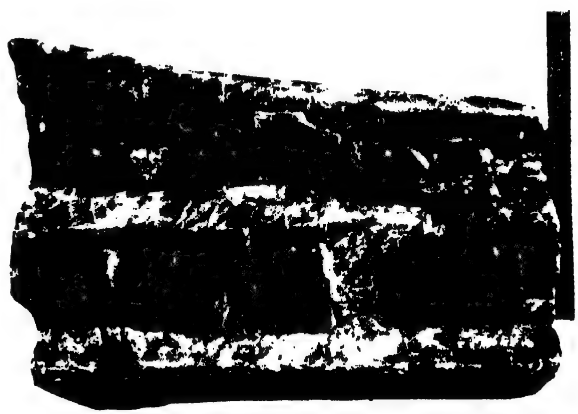
Practically all the barite so far produced in India has come from open-cast quarries, as the workings are shallow. Very little machinery is



1. BARYTES DEPOSIT (Vide Barium Minerals)



2. INDIAN BAUXITE (Pisolitic)



3. BERYL

used in the mines, and the workings generally follow the veins and are developed as long trenches to a depth of 30–35′ from the surface. The veins are excavated with pick and crowbar, and blasting may be resorted to where necessary. The mineral is broken up and sorted at the surface into different grades. The crust or film of iron stain adhering to the lumps is removed by chipping if the lumps are otherwise of good quality.

Practically no crushing and concentration is done in India, since all the material mined is good lump ore. In western countries, the ore is crushed and concentrated by jigs and tables, or by the wet method. Sometimes it is easy to remove limonite coatings and inclusions of pyrite by roasting the ore and passing it through a high intensity magnetic separator. If the stains are in the form of very thin films adhering to the cracks and joints in the lumps, they can be removed satisfactorily by washing the crushed material (10 mesh) with dilute sulphuric acid. Froth flotation is said to be successful in removing associated impurities.

Barite of a pure white colour (first grade) is required for making white paints. Off-colour material (second grade) can be used in coloured paints and as a filler for various purposes. The general specification for the mineral is that it should contain not less than 95% of $BaSO_4$, and a maximum of 1% Fe_2O_3. Barite used in glass-industry must contain at least 96% of $BaSO_4$ and less than 0·1% Fe_2O_3.

According to Mr. B. S. Sanjeeva Reddi of the South Indian Mining Co., Betamcherla, the following are the prices per ton of barite, f.o.r., nearest railway station in the Ceded Dists. :—

	Pre-war Rs.	Present Rs.
First grade, white, lump	30	60
Second grade, off-colour, lump . .	10	18
First grade, white, ground (300 mesh) .	65	125
Second grade, off-colour, ground (300 mesh)	30	80

The largest single use of barite is in the manufacture of the paint pigment, lithopone, which consists of nearly 30% zinc sulphide and 70% barium sulphate. Being a heavy and inert substance, barite is used in the paint industry as an extender, and in paper and rubber industries as a filler. It is generally used in heavy paper, card board, playing cards, etc. As a filler it figures in gramophone records, artificial ivory, linoleum, rubber plastics, printer's inks, textiles, soap, etc. The glass and ceramic industries use barite, barium being a constituent in certain types of optical glass. X-ray tubes are sometimes encased in a cover containing barite, while plaster containing the mineral is used to cover walls of rooms in which X-ray sets are housed. In recent years, barite has been used as an ingredient of heavy drilling muds employed in oil-well drilling.

The soluble salts of barium are highly poisonous. Barium nitrate is employed in pyrotechnics. Precipitated barium sulphate (*blanc fixe*) is used in paints, and as an indicator in X-ray photography. The metal can be prepared by reduction of the oxide by aluminium. Barium alloys find use mainly in the wireless industry. The sulphide obtained by the reduction of the sulphate serves as raw material for the manufacture of barium chemicals.

Prior to 1918 there appears to have been practically no production of barite in India. Since then there has been a steady production of some 5,000 tons a year. An increase to 15,689 tons took place in 1937.

AVERAGE ANNUAL INDIAN PRODUCTION, AND IMPORTS OF BARITE

In quinquennium ending	Madras (Tons)	Rajputana (Tons)	Total Production (Tons)	Total Production (Rs.)	Imports* (Tons)	Imports* (Rs.)
'28	637	1,539	2,176	15,549	1,039	82,885
'33	3,989	973	4,954	37,279	3,356	1,84,126
'38	7,242	338	7,637	32,968	1,368	76,385
'43	13,280	710	14,302	1,04,745	134	13,468
In '44	13,567	1,111	15,299	1,79,358	38	9,825
'45	22,703	1,015	..	..	3	1,357

* For the financial year ending in March.

The value of Indian production given in the table corresponds to the price of ungraded baryte ex mines. The imported product is of superior quality and is usually employed in paint and paper industies.

The world production of barite is of the order of 800,000 tons per year, the share of India in this being only 1 per cent. The chief producers are Germany, U. S. A., Great Britain, U. S. S. R., Italy, Greece and France.

Indian deposits of barite are fairly extensive, especially in the Ceded Dists. Though no estimates have been made of reserves even in restricted areas, it is believed that the deposits are large enough to meet the domestic demand for many years. The workings are all very shallow and production is capable of expansion. The demand is mainly for paints and oil-well drilling. The paint industry takes mostly the best grade white material. It should be possible to utilize the off-colour material for the preparation of barium compounds.

BARLERIA Linn. ACANTHACEAE

The genus comprises approximately 180 species of undershrubs or shrubs, distributed in the warmer parts of the world. Of these about 30 species occur in India.

The following are considered medicinal : *B. buxifolia* Linn., *B. courtallica* Nees, *B. cristata* Linn., *B. longifolia* Linn., *B. prionitis* and *B. strigosa* Willd. (*vide* Rama Rao, 304). The leaves and roots are used for cough and in inflammations.

Several species bear handsome flowers and are cultivated as ornamental hedge-plants : *B. gibsonii* Dalz., *B. lupulina* Lindl., *B. montana* Nees, *B. noctiflora* Linn., *B. polytricha* Wall. and *B. prionitis*. They are readily propagated by cuttings.

B. prionitis Linn.

D. E. P., I, 400 ; Fl. Br. Ind., IV, 482; Pl. XXIV,1.

SANS.—*Karunta* ; HIND.—*Jhinti, katsareya* ; BENG.—*Kanta jati* ; MAR.—*Pivali koranti* ; GUJ.—*Kantashelio* ; TEL.—*Mullu goranta* ; TAM. & MAL.—*Shemmuli* ; KAN.—*Mullu gorante*.

A spiny shrub, reaching a height of 2–5′. It flowers in the cold season and bears orange-yellow or cream-coloured flowers. It is commonly grown as a low hedge-plant and is found throughout the hotter parts of India, Burma and Malaya, and extends westwards to tropical and South Africa.

The juice of the leaves is slightly bitter and acid. It is generally administered in a little honey or sugar in catarrhal affections of children which are accompanied by fever and much phlegm. A paste of the roots is applied to boils and glandular swellings (Dymock, Warden & Hooper, III, 43). The leaves are also chewed to relieve toothache.

The plant is said to be rich in potassium (Wehmer, II, 1144).

Barley, see **Hordeum vulgare**

BARRINGTONIA Forst. LECYTHIDACEAE

A genus of evergreen trees or shrubs, including some 45 species, distributed from tropical Africa to Formosa, Polynesia and northern Australia. Many of them are common in mangrove swamps. 9 species are found in India.

The seeds and bark of some species contain saponin and are used as fish poison and in medicine.

B. acutangula Gaertn.

D. E. P., I, 401 ; Fl. Br. Ind., II, 508 ; Beddome, Pl. 204.

HIND.—*Ingar* ; BENG.—*Hijal* ; MAR.—*Pivar* ; TEL.—*Kadapa*; KAN.—*Hole kauva*; BURM.—*Kyeni*.

A moderate-sized evergreen tree, reaching a height of 30–40′ and a girth of 6′, with a rough dark-brown bark about 0·5″ in thickness.

The tree is fairly common in sub-Himalayan tracts, east of the Jumna, in Bihar, Orissa, Bengal, Assam, the Central Provinces and south India ; also in Ceylon and Burma. It prefers moist situations, but is not found in mangrove forests.

Its tender leaves are edible (Pfleidrer, 63). The bark, root, and seeds are reported to be employed as fish poison. They probably contain saponin (Dymock, Warden & Hooper, II, 18). The powdered seeds in doses of a few grains are given to children as an expectorant and emetic. The leaves and roots are bitter tonics (Kanny Lall Dey, 44).

The bark contains 16% tannin, and is reported to be used as a tan in Burma (*Indian For. Leafl.*, No. 72, 1944, 5).

The wood is pinkish to reddish-grey, sometimes nearly white towards the outside of the log, and heartwood is not distinct. The wood is soft, moderately strong and fairly durable. It seasons well, but is liable to warp. It is a light wood (sp. gr., 0·58 ; air-dry wt., 37 lb. per c. ft.), easy to saw and work by hand, and machines and finishes to a dull smooth surface. It is used for boat-building and in cabinet work (Pearson and Brown, II, 563). The calorific value of moisture-free sapwood (ash, 2·95%) is 5078 cals. (*Indian For. Bull.*, *New Series*, No. 79, 1932, 12).

B. asiatica (Linn.) Kurz Syn. *B. speciosa* Forst.

D. E. P., I, 403; Fl. Br. Ind., II, 507; Pl. XXVI, 1.

SINGHALESE—*Mudilla.*

An evergreen tree, 30–50′ high, usually found on sandy beaches and distributed from Ceylon and the Andamans to the Malay Peninsula and Australia.

The bark and fruits after being pulped are used to stupefy fish to capture them. The insecticidal potency of a sample of bark from Australia was found to be very low (*Kew Bull.*, 1940, 170).

In spite of its use as a fish poison, the fruit is reported to be eaten in Indo-China. This is possible when it is properly cooked so as to destroy or remove saponins (Burkill, I. 304).

The wood is pale, and soft. It is suitable for floats, but is not durable (Lewis, 194).

B. racemosa Roxb. Syn. *B. racemosa* Blume

D. E. P., I, 402; Fl. Br. Ind., II, 507.
Indian names from SANS. *Samudraphala.*

A moderate-sized evergreen tree, with drooping branches, found in the West Coast of India from Konkan southwards, the Sundarbans, Assam, and the Andaman Islands. The ovoid fruit is 2–2·5″ in length. The seeds about 1″ in length are rich in starch.

The tender leaves are said to be eaten in eastern Malaysia (Burkill, I, 306). The primitive tribes of Malaya are reported to extract starch from the seeds for use as food (*Kew Bull.*, *loc. cit.*).

A sample of bark from Travancore was found to contain tannin, 18% (*Indian For. Leafl.*, *loc. cit.*). The seeds and the bark are used as fish poison. In the Phillippines, the fruit is also used to poison wild pigs (Burkill, *loc. cit.*). The fruit, the seeds and the root are said to be medicinal.

The alcoholic and cold and warm aqueous extracts of bark are toxic to citrus aphis (probably *Toxoptera aurantii* Boy.) at concentrations representing 2–2·5% of bark. The bulk of the toxic principles are found in the resin fraction. But *B. racemosa* is not likely to replace the more potent insecticides of the derris class (*Kew Bull.*, *loc. cit.*).

The wood is white and soft, and is not of much use except as firewood (Gamble, 363).

Basalt, see **Building Stones**

BASELLA Linn. BASELLACEAE

Includes only one species, found throughout the Old World tropics.

B. rubra Linn. INDIAN SPINACH

D. E. P., I, 403; Fl. Br. Ind., V, 20.

HIND., BENG., & MAR.—*Poi*; TEL.—*Batsala*; KAN.—*Basale*; MAL.—*Basala.*

A perennial twining herb, with leaves up to 5″ by 3″. They are broadly ovate, and pointed at the apex. The young stems and leaves are markedly fleshy.

B. alba and *B. cordifolia* have been described as distinct species, but are generally considered to be only varieties of *B. rubra.*

The plant is grown as a pot-herb in almost every part of India, except the hills. The red-leaved and green-leaved varieties are equally common in Bengal, Assam and south India, while the green-leaved ones are found more often in the United Provinces and the Punjab. The plants can be raised either from seeds, or from root or stem cuttings, and a spacing of 3′ is given between them. They are often made to grow on stakes and are ready for picking in 80–90 days.

The tender stems and leaves make a very wholesome spinach. The plant is reported to contain: protein, 1·2; calcium, 0·15%; iron, 1·4 mg.; vitamin A, 3,250 I.U.; vitamin B_1, 40 I.U.; vitamin B_2, 10 Sherman U./100 g. (Corpn. Calcutta, Food Values of Common Indian Food-stuffs, 1943, 4; cf. Ghosh and Guha, *Indian J. med. Res.*, 1933, **21**, 447).

The colouring matter of the red variety is reported to have been used in China as a dye for official seals as well as for rouge. It can serve for colouring jellies, but it is not considered good to use much of it. The addition of a little lime juice brightens the colour. The ripe fruits of some races contain a deep violet colouring matter which is sometimes used for colouring food, etc.

The pulped or bruised leaves, on account of the presence of mucilage, are used as poultice. The juice of leaves is prescribed in cases of constipation, particularly in children and pregnant women (Burkill, I, 307), and in urticaria.

Basil, see **Ocimum**

Bassia Koenig ex Linn., see **Madhuca**

BASSORA GUM

This is also known as *Katira* gum, and includes several varieties of gums which have properties similar to those of gum tragacanth. They swell up in water absorbing large quantities, but do not dissolve in it. The principal species which yield bassora gum according to Trotter (1940, 284) are: *Cochlospermum gossypium*, *Salmalia malabarica* (syn. *Bombax malabaricum*) and *Sterculia urens*. The gum of the last species is of importance and is known in trade as karaya gum.

BAUHINIA Linn. LEGUMINOSAE

A genus of 250 species of trees, shrubs and climbers distributed throughout tropical regions. Nearly 40 species occur in India.

A few species yield tannin, e.g. *B. malabarica*, *B. racemosa* Lam., *B. rahlii* and *B. purpurea*. Fibre of local interest is obtained from the barks of *B. anguina* Roxb., *B. macrostachya* Wall., *B. racemosa*, *B. tomentosa* Linn., and *B. vahlii*. *B. racemosa*, *B. retusa* and *B. variegata* also yield gum. The wood of *Bauhinia* spp. is not of much value.

Some species such as *B. acuminata* Linn. and *B. variegata* are cultivated as ornamental plants on account of their flowers.

B. malabarica Roxb.

D. E. P., I, 420; C. P., 120; Fl. Br. Ind., II, 277.

HIND.—*Amli, amlosa*; BENG.—*Karmai*; TEL.—*Pulishinta*.

A medium-sized, bushy deciduous tree, occurring in sub-Himalayan tracts, in Bengal, Assam, south India and Burma.

Its bark contains 9–12% of tannin (*Indian For. Leafl.*, No. 72, 1944, 5). It imparts a red colour to leather and is not of much value as a tan (Burkill, I, 309).

Young shoots and leaves are reported to be acrid, but are eaten in Burma and in the Konkan. The tree is said to give good fodder for cattle (*Indian For.*, 1940, **66**, 14).

The wood is reddish-brown, moderately hard and fairly straight-grained (air-dry wt., 43 lb. per c. ft.) but is rarely used (Pearson and Brown, I, 418).

B. purpurea Linn.

D. E. P., I, 421; C. P., 120; Fl. Br. Ind., II, 284; Kirt. & Basu, Pl. 366.

HIND. *Khairwal*; BENG. & MAR.—*Deva* or *rakta kanchan*; TEL.—*Kanchanam*; TAM.—*Mandari*.

A moderate-sized ornamental evergreen tree, with pink flowers, distributed in sub-Himalayan tracts, rising to 4,000′, also in Assam, Khasi Hills, Chittagong and the western Peninsula.

The tree yields gum. The bark is reported to contain tannin. The leaves are used as fodder, and the flower buds are reported to be used as pot-herb.

The seeds contain 15% of a non-drying oil (sp. gr./30°, 0·915; $n_D^{30°}$, 1·467; sap. val., 203; iod. val., 85·5. Kafuku and Hata, *Chem. Abstr.*, 1933, **27**, 202; 1934, **28**, 5266).

The wood is greyish brown, moderately soft and light (air-dry wt., 36 lb. per c. ft.), and is liable to attack by wood-borers and white ants. It is used for agricultural implements and is suitable for scantlings and rafters in inferior construction work (Pearson and Brown, I, 423).

B. retusa Roxb.

D. E. P., I, 423; C. P., 121; Fl. Br. Ind., II, 279; Kirt. & Basu, Pl. 364.

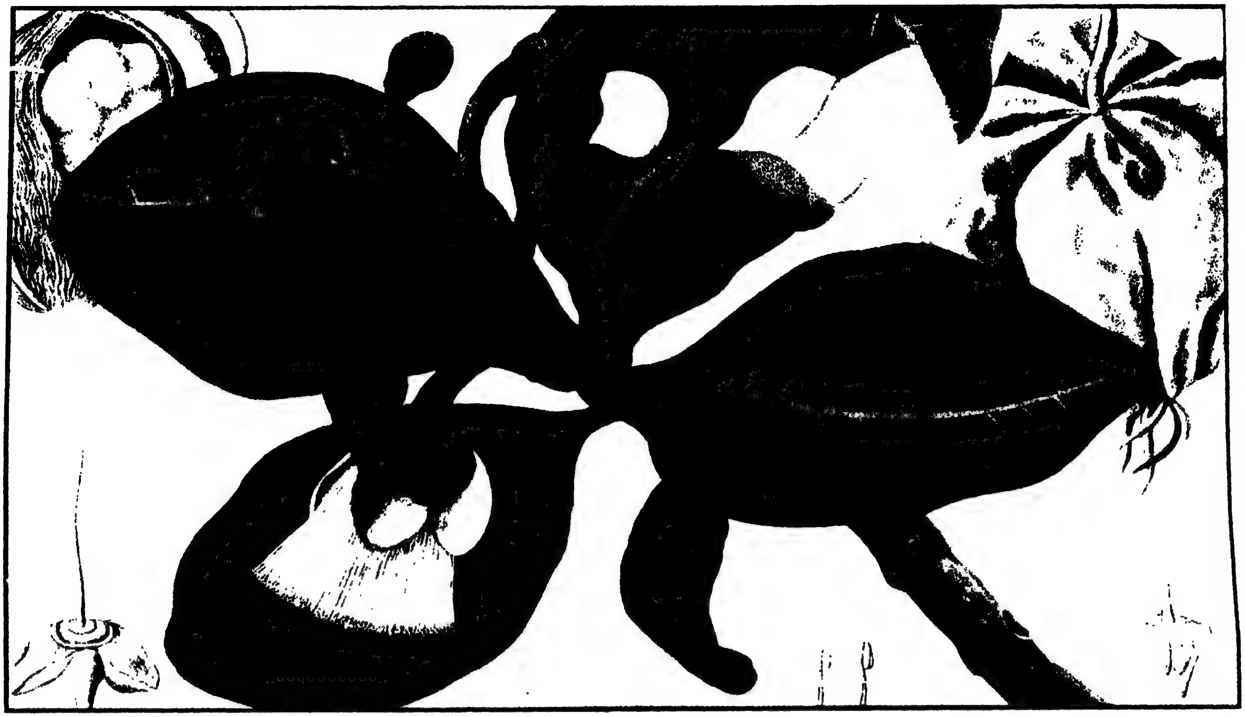
HIND. *Semla*; TEL.—*Nirpa*.

A medium-sized deciduous tree, distributed in the north-western Himalayas ascending to 4,500′ in the forests of Siwaliks, Oudh, Orissa, Northern Circars and the Central Provinces.

The plant yields a gum, locally known as *semla-gond*, resembling gum arabic. It used to be collected in the forests of Dehra Dun and Saharanpur to meet local demand for sizing cloth and paper, and for water-proofing terraced roofs. It is sometimes eaten by the poorer classes. It may be used as a binder in the manufacture of charcoal briquettes (Trotter, 1940, 285; Dunstan, *Agric. Ledger*, 1900, **7**, 115).

The wood, about the best of the *Bauhinia* species, is reddish brown, heavy and narrowly interlocked-grained (air-dry wt., 45 lb per c. ft.). It could be used for rafters, scantlings and posts (Pearson and Brown, I, 421).

The calorific value of moisture-free heartwood (ash, 3·25%) is 5,027 cals. (*Indian For. Bull., New Series*, No. 79, 1932, 12).



1. BARRINGTONIA ASIATICA

2. BERRYA CORDIFOLIA

B. vahlii Wight & Arn.

D. E. P., I, 424 ; C. P., 121 ; Fl. Br. Ind., II, 279 ; Pl. XXIV, 3.

HIND.—*Maljan* ; BENG.—*Sihar* ; MAR.—*Chambul* ; TEL.—*Adda*.

A gigantic climber and one of the most abundant of Indian climbing *Bauhinia* spp. It is distributed in the sub-Himalayan region ascending to 3,000′, also in Assam, C. P., Bihar and Tenasserim.

The fibre from the inner bark is used for making ropes for domestic purposes. The outer bark yields 17% tannin, and 19% non-tans. The stem contains 8% tannin (*Indian For. Leafl.*, *loc. cit.*). The stem produces a tan which penetrates hides quickly and produces a soft, pale, cream-coloured leather. The tannin is present in the cementing material between the fibres and has to be combed out to make it marketable (Burkill, I, 312).

The seeds are eaten, raw or fried. When ripe, they taste like cashew nuts. The leaves are used for thatching and for making umbrellas, etc. (Trotter, *loc. cit.*, 305).

B. variegata Linn.

D. E. P., I, 425 ; C. P., 121 ; Fl. Br. Ind., II, 284 ; Pl. XXIV, 2.

HIND. & MAR.—*Kachnar* ; TAM.—*Segapu-manchori* ; KAN.—*Kanchavala*.

A medium-sized tree, flowering during the hot season, distributed in the sub-Himalayan tract from the Indus east-wards, also in dry forests over eastern, central and south India, and in Burma.

The tree yields a gum similar to cherry gum. Its bark is reported to be used in dyeing to obtain various fast shades of brown (De, 13). The leaves and buds are edible. The plant is said to yield good fodder for cattle (*Indian For.*, *loc. cit.*).

The bark is described as astringent, alterative, tonic, and useful in scorfulla, skin diseases and ulcers (Kanny Lall Dey, 45).

The seeds consist of 20% endocarp, and 80% kernels. They yield 16·5% of a pale yellow fatty oil on extraction with petroleum ether, but only about 6·1% when expressed in a hydraulic press. The pressed oil has the following constants: sp. gr. /30°, 0·921 ; $n_D^{30°}$, 1·460 ; sap. val., 211·0 ; iod. val., 913 (Puntambekar and Krishna, *J. Indian chem. Soc.*, 1940, **17**, 96).

The wood is greyish brown and moderately hard (air-dry wt., 44 lb. per c. ft.), and is used for agricultural implements (Gamble, 284).

The calorific value of moisture-free sapwood (ash, 3·02%) is 4,791 cals. (*Indian For. Bull.*, *New Series*, *loc. cit.*).

BAUXITE

The word 'Bauxite' has been derived from Les Baux near Arles (France), where the mineral was first discovered in 1821. Indian bauxite is invariably associated with laterite, of which it is now regarded as a variety. True laterite is essentially a mixture of ferric hydroxide, aluminium hydroxide and silica, in varying proportions. It is spoken of as aluminous laterite or ferruginous laterite, according to the relative proportions of aluminium hydroxide and ferric hydroxide. If it contains over 50% of alumina, it is termed 'aluminium ore of bauxite type' ; and if it is sufficiently free from impurities (chiefly silica), and is suitable for the extraction of alumina, it is called 'bauxite'.

Bauxite is essentially a hydrated aluminium oxide, $Al_2O_3.2H_2O$ (Al_2O_3, 73·9%). It appears to be a mixture of the minerals, diaspore, $Al_2O_3.H_2O$ (Al_2O_3, 85·0%), and gibbsite, $Al_2O_3.3H_2O$ (Al_2O_3, 65·4%). Much of the alumina of bauxite is, however, believed to be present in the form of colloidal hydrogels, with variable combined water content. The common impurities are silica (as clay minerals or quartz), iron oxide (as haematite or limonite), and titanium oxide (as leucoxene or rutile). Sometimes, lime, magnesia, and manganese oxide may be present in small amounts.

The range of composition of bauxites is usually: Al_2O_3, 55–65 ; SiO_3, 5–30 ; Fe_2O_3, 1–25 ; TiO_3, *ca.* 3 ; and loss on ignition, 12–40% (Liddell, II, 4). The best French white bauxite contains: Al_2O_3, 66–74 ; SiO_2, 6–10 ; Fe_2O_3, 2–4 ; TiO_2, 3–4% (Brady, 68 ; see also Rogers, II, 949). Ordinarily bauxite is a dirty white, light grey, cream, pink or reddish-brown rock (sp. gr., 2·5–3·2 ; H., 2·5–3·5 ; m. p., 1820). The sp. gr. of gibbsite (H., 2·5–3·5) is somewhat less, 2·3–2·4, and that of diaspore (H., 6·5–7·0) is more, 3·3–3·5. The softer kinds of bauxite become harder on exposure. Bauxite is amorphous and is usually compact, earthy, granular or porous,

often with a concretionary (oolitic or pisolitic) structure (Pl. XXV, 2). The pisolites generally have a concentric structure, with a core of grey clayey or dark ferruginous matter, or of crystalline gibbsite.

It is often difficult to distinguish between bauxite and clay. The pisolitic or shot-like appearance (if present), and its granular structure, are two of its characteristic properties. Bauxite, however, may contain a certain proportion of clay as impurity, and it may also show some plasticity. Its quality may be judged by grinding a dried sample in an agate mortar for half a minute. Good bauxite will be found hard to grind; it will stick to the mortar and will have to be scoured out. Poor bauxite or bauxite clay will grind more easily and will stick very little. Clay or kaolin will grind very easily, and will not stick to the mortar (Coggin Brown, *Bull. Indian Industr. Lab.*, No. 12, 1921).

Bauxite results from the decay and weathering of aluminium bearing rocks (igneous, sedimentary or metamorphic). The process involves the solution and removal of all the constituents of the parent rock, other than alumina. In India, the richest deposits of bauxite are commonly associated with primary laterite, formed from sub-aerial weathering of basaltic lavas, like the Deccan Trap. Good deposits of bauxite are found on laterite-capped plateaux or flat-topped hills. A peculiar white or yellowish clay, called 'lithomarge', interlaminated with red or yellow ochres often occurs at the base of the laterite and bauxite mantle. The most promising places for the discovery of bauxite deposits are the concave portions of the scarps of these hills, usually the upper 3–10′, and the beds of streams on the bigger plateaux. Deposits of cream coloured bauxite often occur below a thin covering of highly ferruginous laterite. The presence of lithomarge on flat-topped laterite hills is considered a favourable indication for the occurrence of bauxite.

DISTRIBUTION

(Fox, *Mem. geol. Surv. India*, 1923, **49**, i; and Bauxite and Aluminous Laterite, 1932).

Bihar: In Palamau dist., small deposits of bauxite occur on Jamira Pat plateau, west of Mhowadand (23°24′ : 84°7′) and Neturhat (23°29′ : 84°16′). Specimens of bauxite from this area were found to analyse: Al_2O_3, 59·32–64·64%.

Important deposits of bauxite occur on several flat-topped laterite-capped plateaux, in Ranchi dist., near Lohardaga (23°26′ : 84°43′).

On Dudmatia Pat (3,476′; 23°29′ : 84°36′) there are about 500,000 tons of good bauxite (Al_2O_3, 50–60%), but with high titania content (TiO_2, 10–17%). It is possible that titania is not uniformly distributed in the ore. Deposits of excellent white clay are found associated with this bauxite, and hence the name of the plateau. There are at least 250,000 tons of excellent bauxite (Al_2O_3, 62; TiO_2, 9%), on Dudha Pat (23°25′ : 84°31′). More than 60,000 tons of bauxite (Al_2O_3, 51·69; TiO_2, *ca.* 12%), occur on Salgi Pat (3,514′; 23°26′ : 84°41′). Over 50,000 tons of bauxite are available on Banjari Pat (3,480′; 23°23′ : 84°30′). Roughly 100,000 tons of good bauxite (Al_2O_3, 59; TiO_2, *ca.* 9%) are found on Kutcha Pat (23°12′ : 84°20′). Considerable quantities of good bauxite occur on Pakhar Pat (23°34′ : 84°36′), Chapuadhia Pat (23°28′ : 84°34′), and on Pakri Pat near Rajadera (23°17′ : 84°16′). In addition small deposits also occur on several other plateaux in this area.

Bombay: In Belgaum dist., bauxite occurs on the Nauga hill (3,294′; 15°48′ : 74°26′). Its thickness varies from 5–25′, and it is estimated that there are roughly 75,000 tons of better quality ore (Al_2O_3, *ca.* 59; TiO_2, *ca.* 6%), and more than 2 million tons of bauxite with about 49% of alumina. Good bauxite also occurs on the double-peaked mass of hills over the village of Kiniya (15°46′ : 74°26′). Bauxite cappings on each of the hills is roughly 100,000 tons and is about 20′ thick. A specimen of good quality bauxite from these hills was found to contain: Al_2O_3, 55·86; TiO_2, 7·90; SiO_2, 1·89; Fe_2O_3, 7·08; and MgO, 0·24%.

Good bauxite occurs on several other hills in this district although in some places the quantity is small: Jamboti and Bailur ridges; Kalanandigarh and Malangadda hills; Mahipalgarh ridge; Kasarsadda or Kasarsora plateau; Rajhosgad hill; and Ambevadi or Keruali Mut hill.

In Kolhapur State, about 2 million tons of good bauxite (Al_2O_3, 59·35; TiO_2, 7·00; SiO_2, 3·44; Fe_2O_3, 4·25; and MgO, 0·64%) occur on the elongated plateau, NW. of Radhanagri or Valivda (16°25′ : 74°0′). About 8–10 million tons of

bauxite (Al_2O_3, 50–60; TiO_2, *ca.* 8%) occur on Dhangarvadi hill (3,335′; 16°55′ : 73°51′).

Other deposits of good bauxite in Kolhapur are on Panhala Fort (16°49′ : 74°7′), Gaola-ka-Sera (16°1′ : 74°6′), Rangewadi (16°51′ : 73°56′), Gargotti (16°19′ : 74°8′), and on the hills west of Nesari (16°33′: 74°20′). The bauxite of Panhala Fort (Al_2O_3, 62·32–64·77%) is perhaps the best grade bauxite found in India, but the quantity is very small (*Rec. geol. Surv. India*, 1923, **54**, 419).

The Kapadvanj deposit (23°1′ : 73°4′), in Khaira dist., has contributed the major portion of the annual output of Indian bauxite (8,971 tons per annum between 1924 and 1929, and 5,592 tons in 1937). The ore occurs as aluminous laterite in loose boulders having pisolitic texture. It lies on the surface and has merely to be dug out. The high grade ore contains: Al_2O_3, 55·41; TiO_2, 6·71; SiO_2, 1·2; and Fe_2O_3, 7·0%. It has been used by petroleum companies for the purification of kerosene. A rich deposit of bauxite also occurs near Taibpur (23°3′ : 73°5′) in Kapadvanj taluk.

In Thana dist., good bauxite occurs with the laterite cappings on Baumdongri (19°10′ : 72°57′), Bombassadongr (1,280′; 19°11′ : 72°57′), and Tungar plateau.

Central India: In Rewah State, bauxite occurs on the Amarkantak plateau, part of which lies in Bilaspur dist. of the Central Provinces. Excellent bauxite occurs on the Miria hill (22°48′ : 81°44′) on the Norbada-Johilla watershed, and near Lilwani hill (22°46′ : 81°50′).

Sharma (*Quart. J. geol. Soc. India*, 1931, **3**, 157) describes the occurrence of bauxite in Sohawal State on the Nero plateau within easy reach of Satna railway station.

Central Provinces: Most of the bauxite areas between Jubbulpore and Katni in Jubbulpore dist., are situated conveniently for transport by rail and road. The principal deposits are at Mahgawan (23°34′ : 80°14′), Dhangawan (23°34′ : 80°11′), Saraswahi (23°38′ : 80°19′), Tikaria (23°44′ : 80°24′), Murwara or Katni (23°50′ : 80°24′), Bargawan (23°50′ : 80°23′), Tikuri (23°49′ : 80°23′), and Flag-Staff hill (23°48′ : 80°23′). The reserves on Dhangawan ridge are about 100,000 tons; in Tikaria area, about 7 million tons (of which 2 million tons are of good quality); in Katni, about 1·5 million tons of good quality; and in Bargawan hill, about 4 million tons, of which 1·2 million tons are of fair quality; in Tikuri, about 300,000 tons of good bauxite; and in Flag-Staff hill, about 1 million tons of good grade and 3 million tons of poor grade ore.

The average composition of Jubbulpore bauxites of good quality is: Al_2O_3, 60; TiO_2, 8; SiO_2, 2·5; Fe_2O_3, 3–4; combined water, 26; and moisture, 0·5%. The best grades contain Al_2O_3, 60–65%. Production from Jubbulpore dist. averaged 2,312 and 7,125 tons, during the quinquennia ending '33 and '38.

In Balaghat dist., bauxite occurs on a ridge west of Uskal river (22°0′ : 80°21′); in Laughar area (21°56′ : 80°21′) between the Uskal and Nahara rivers; on the Baihar plateau (22°6′: 80°33′), and on the Topla highlands. The bauxite on Warjiri (21° 57′: 80° 23′), Gad Dadar or Pachama (21°53′ : 80° 26′), and Sarad Dadar (21°53′ : 80°30′) hills in the Laughar area contains alumina, 52–58%. On the Baihar water-shed also, there is considerable amount of good bauxite containing alumina, 48–64%. On the Topla highlands some of the promising localities for good bauxite are near Lapti (22°10′ : 80°46′), Sukri (22°8′ : 80°54′), and Baldongri (Kusera Dadar, 22°14′ : 80°59′).

In Bilaspur dist., bauxite occurs on the scarps and slopes of Amarkantak plateau as well as of Ajmirgarh or Rajmergar plateau. Some of the bauxite near Amarkantak contains more than 60% of Al_2O_3.

Eastern States: In Bastar State, Crookshank (*Rec. geol. Surv. India*, 1939, **74**, 31) reports the occurrence of bauxite associated with laterite, on the Tarali Metta (18°32′ : 81°14′), and at the water-shed between the Bailadila and Galli *nalas* (canals) 1½ miles south of Bailadila Guest House (18°44′ : 81°14′). The ore is first class low titanium bauxite containing about 62% of alumina.

According to Dey (*Rec. geol. Surv. India*, 1942, **74**, 31), titaniferous bauxite of good quality occurs at several localities, on Khuria highlands in Jashpur State. But these are somewhat difficult of access, and are more than 80 miles from the nearest railway station, Lohardaga.

In Kalahandi State, bauxite occurs in Korla Pat area, in association with the laterite formed

from the weathering of Khondalite rock. According to Krishnan (*Rec. geol. Surv. India*, 1926, **59**, 419), a band of yellow bauxite of good quality (Al_2O_3, 61·92 ; Fe_2O_3, 4·44 ; SiO_2, 2·30 ; TiO_2, 2·77%), with a vertical thickness of 15′ and a horizontal extent of about 450–500′, occurs in the ferruginous laterite on the western flank of Korlapat hill, east of Polengoodor (19°37′ : 83°10′).

Kashmir : Extensive deposits of generally hard and dense variety of aluminium ore (sp. gr., 2·96–3·25 ; Al_2O_3, 70–80 ; combined water, *ca.* 15%), which is an amorphous form of diaspore, occur in Riasi dist. of the Jammu province of Kashmir. The 'Bauxitic Series' occurs as a capping over the Great Limestone and its residual breccia rock, and is at places overlaid by the Eocene coal-measures. It is composed of an upper layer of aluminium ore (pisolitic and non-pisolitic), and a lower layer of kaolin (which may also be pisolitic), with varieties intermediate between the two. The total reserves of first grade aluminium ore (Al_2O_3, 75–80 ; SiO_2, 1–5%) in the five main areas of the Jammu province (Chakar, Sangar Marg, Salal, Panhase and Sukhwalgali-Jungalgali) are estimated at nearly 1·8 million tons. The Jammu ore is very refractory and involves greater cost in grinding and is not easily soluble in caustic soda (Middlemiss, Miner. Surv. Rep. Jammu & Kashmir, Bauxite.

According to Wadia (*Rec. geol. Surv. India*, 1935, **69**, 28 ; *Mem. geol. Surv. India*, 1928, **51**, 365), a bed (1–3′ thick) of dense bauxite, almost free from iron, occurs at the base of the Eocene Nummulitic series in the Kotli tahsil of Jammu province. Several hundred thousand tons of fair grade ore are available at the surface. Similar bauxite deposits occur between Nanda Gali and Manehtaur in Poonch State. The quantity available here is 600,000–800,000 tons.

Madras : Cappings of bauxite and laterite occur on six of the highest peaks in the Shevaroy hills, Salem dist. They exhibit the characteristic flat topography of laterite plateaux. The deposits are 30–40′ thick, and below this depth the material grades into lithomargic clay and undercomposed rock. It contains 45–50% of alumina and about 20% of water. But in actual working it should be possible to eliminate the more ferruginous material. At a conservative estimate, the total tonnage of bauxite in these deposits is of the order of 6–7 million tons, of which one-third is of good marketable quality (Krishnan, *Rec geol. Surv. India*, 1942, **77**, *Prof. paper*, No. 8).

Mysore : Small patches of bauxite occur on the Bababudan range. These are estimated to yield about 100,000 tons of ore containing more than 55% of Al_2O_3. About 100,000 tons of siliceous bauxite (Al_2O_3, 30%), suitable for making aluminous sulphate, occur near Sivaganga in Holalkere taluk, Chitaldrug dist. (Rama Rao, *Quart. J. geol. Soc. India*, 1942, **14**, 174).

MINING AND UTILIZATION

In India, bauxite deposits which are laid bare on the surface without any overburden, are merely dug out after clearing the upper surface. Such are the deposits in Kashmir and in Kapadvanj (Bombay). If there is a thin overburden of loose material over the deposit, as on several of the laterite plateaux, the overburden is first removed by stripping. When it is too thick, or when the bauxite layer occurs between massive strata, or dips into the hill for a considerable depth, quarrying method is used at the outcrops, and ordinary underground mining is followed at depths. So far, in India, bauxite has been extracted only by quarry methods.

Sometimes, crude bauxite as mined, is sent direct to aluminium works ; but in many cases, it is crushed and washed to remove a large proportion of clay, ferruginous matter and other impurities. Washing is usually done by simple devices such as log washers ; by this, siliceous matter is not so easily removed from the ore as ferruginous matter. In the U.S.A., to reduce transport charges, washed bauxite is dried in rotary kilns before it is shipped.

The major portion of the world output of bauxite is used for the extraction of alumina (m.p., 2050°), required for the preparation of aluminium by electrolysis. In the Bayer process, which is usually employed for its preparation, bauxite is finely ground and calcined below red heat. It is then digested with caustic soda (45%) in autoclaves, until all the alumina goes into solution forming sodium aluminate. The liquor, diluted with an equal volume of water, is allowed to settle and filtered from the residues, the red 'mud', consisting of ferric oxide, silica, titania, etc. The filtered solution is transferred to

large open tanks fitted with agitators, 'seeded' with a small amount of freshly prepared aluminium hydroxide, and well stirred. Aluminium hydroxide gradually separates from solution, is filtered, washed and calcined to yield pure alumina.

The electrolytic bath consists essentially of sodium fluoride and aluminium fluoride (cryolite $AlF_3 . 3NaF$), with other salts such as calcium fluoride (fluorspar), which reduce the melting point and lower the specific gravity of the fused bath. A typical bath approximates to the formula, $2AlF_3 . 6NaF . 3CaF_2$, and when fused at 950° dissolves, about 20% of Al_2O_3. During electrolysis aluminium (m.p., 658°) separates at the cathode in the molten state and is periodically drawn off.

Bauxite used for the manufacture of aluminium should be rich in aluminium and contain only small amounts of silica. In the U. S. A., the ore is required to analyse: Al_2O_3, >52; SiO_2, <4·5; Fe_2O_3, <6·5%. During the War ('39–45) attempts have been made to utilize low-grade ores and even clayey materials for the production of alumina (Liddell, 10). An objectionable feature of some Indian ores is their high content of titania. In good quality ores its proportion should not exceed 2%.

The second largest use of bauxite is for the preparation of certain salts of aluminium, chiefly alum and aluminium sulphate. For this, the ore must be rich in alumina capable of readily going into solution in dilute sulphuric acid, and should contain only small quantities of ferric oxide and titania (<3% each). No limits are set on the proportion of silica, and ores containing up to 19% of SiO_2 have been utilized for the preparation of aluminium salts.

Bauxite is also used in the manufacture of artificial abrasives such as artificial corundum and emery, 'alundum', etc. The ore is fused in an electric arc furnace and alumina is allowed to crystallize. This is then crushed, ground and mixed with suitable binders, and made into different types of abrasives. These have nearly the same hardness as corundum (H., 9). Bauxite used for abrasives should be low in silica (*ca.* 3%), titania (2·5–4%) and iron (Fe_2O_3, 3–5%). The finer grades of artificial aluminium abrasives are prepared from chemically prepared alumina.

Refractories are manufactured out of bauxite low in iron and titanium, or diaspore clays. Bricks are moulded from calcined bauxite mixed with a clay binder, and fired. These are used for lining open-hearth steel furnaces, as they are highly resistant to heat and abrasion, and are chemically inert at high temperatures. Quick-setting cements are prepared by fusing bauxite and limestone. These are called 'fused cements' and set in 24 hours, and are unaffected when exposed to sea-water.

Bauxite, after suitable roasting, develops a peculiar porous structure and becomes an extremely efficient refining agent. It has been used by the Burma Oil Company, for many years, for the refining of kerosene and paraffin wax, and is now entering sugar refineries. It has the advantage that it can be revivified indefinitely by burning (Thorpe, I, 657).

PRODUCTION

The world production of bauxite in 1938 was about 4 million metric tons. The leading producing countries in the order of their output in 1938 were France, Hungary, Yugoslavia, British Guiana, Dutch Guiana, Italy, the United States, the U.S.S.R., the Netherlands East Indies and Greece. Each of these countries produced more than 175,000 metric tons, and together they contributed about 97% of the total production.

The presence of workable deposits of bauxite in India was proved in 1905, and the total reserves in the country are estimated at 250 million tons. Production of the mineral on a small scale began in 1910. Bauxite has been mined regularly only from the Khaira dist. (Kapadvanj deposits), and Jubbulpore dist. (Katni deposits). Since 1934 there has been a small export.

ANNUAL PRODUCTION OF BAUXITE IN INDIA

In quinquennium ending	Tons	Rs.
'28	11,326	86,278
'33	4,280	22,659
'38	8,243	22,005
'43	14,476	41,013
In '44	12,135	57,112
'45	13,893	1,31,314

The major portion of bauxite produced in India was being purchased by petroleum

companies for refining kerosene, and small quantities have been used for preparing alum and for the manufacture of aluminous cement. Some Indian bauxite is now being utilized for the production of the metal.

Bdellium, see **Commiphora**

BEAUMONTIA Wall. APOCYNACEAE

A genus of woody climbers, including 8 species distributed in the Indo-Malayan region. Of these, 4 are found in India.

B. grandiflora Wall. (D. E. P., I, 433; Fl. Br. Ind., III, 660) is a gigantic climber, with handsome evergreen foliage and pure white flowers. It grows wild at low elevations, in the Himalayas, from Nepal eastwards to Sikkim and Assam. It is often grown in gardens as an ornamental climber.

Young stems yield a fibre (Gamble, 488). The seeds have tufts of silky hair, 1·5–2″ long, and yield a floss of local importance (Trotter, 1940, 235).

Beda nuts, see **Terminalia belerica**

BEES, Honey

SANS.—*Bhramara*; ARAB.—*Nahal*; PERS.—*Maghas-asal*; HIND.—*Shahad ki makkhi*; BENG.—*Mou machhi*; TEL.—*Thenu eegalu*; TAM. & MAL.—*Thenee*; KAN.—*Jenu hula*.

Honey bees belong to the genus *Apis*. They are social insects which live in colonies and produce honey and beeswax. Each colony has ordinarily one queen or mother bee, a large number of 'workers' which are sterile females, and in some seasons, male bees or drones. The colony builds combs or a single comb, with cells which are used both as cradles for young ones and as store for honey. Bees play an important part in the cross-pollination of plants, especially of fruit trees.

Bees, in their life-history, pass through complete metamorphosis, comprising of egg, larva, pupa and adult phases. The queen-bee is a specially reared and nurtured female, whose sole function is propagation of individuals of the colony. Her span of life is about three years, of which only two constitute the period of vigour and egg-laying. This necessitates requeening a colony every third year. The queen lays two to three thousand eggs daily.

The 'workers' perform all kinds of work necessary in the economy of the colony. They gather nectar and pollen, build combs with wax secreted by them, tend the queen, rear young ones or brood, and attend to other details of life within the hive. The younger ones, 'nurses' work inside the hive, and the older ones are 'foragers'. Their span of life is about one-and-a-half to three months.

The drones are the males of the colony and their only function is to fertilize the queen. In the interests of the economy of the hive, they are maintained only as long as their service is required.

The nectar collected from flowers is converted into honey during the short period it remains in the honey-sac of the worker, before it is transferred to the cells. Honey is usually stored in the upper parts of combs, and the brood reared in the lower parts.

INDIGENOUS BEES

(Pl. XXVII, 1)

The three well-known indigenous species of *Apis* are:

(*i*) *A. dorsata* Fabr., the Rock Bee, the largest Indian species distributed throughout India and Burma at lower altitudes. Each colony of this bee builds a single huge comb, in the open on faces of overhanging rocks, under branches of large trees, and sometimes, under the ceilings of large buildings, the comb measuring about 3–5′ in length and about 2–3′ in width. In forest areas colonies live fairly gregariously, many combs being built on a tree, or in the same neighbourhood. The bees are very good honey gatherers, a single comb yielding up to about 60 lb. of honey, and about 2½ lb. of beeswax. On account of their open air habit, Rock Bees cannot be kept in hives. Besides, they are very irritable, vicious, and migrate from place to place in different seasons.

(*ii*) *A. indica* Fabr., the Indian Hive Bee, is found throughout India and Burma, and ascends up to 9,000′. In nature, colonies of this bee always live and build combs in covered situations, like cavities in tree trunks, rocks or walls. They build several combs side by side and parallel to one another. Sometimes they occupy unused boxes, packing cases and protected niches in houses. This is the only indigenous species capable of being kept in artificial hives,

Two distinct varieties of this bee occur, one in the plains, and the other in the hills. The hill variety is larger and also darker in colour and is a better honey gatherer. The yield of honey from a domesticated colony of the plains variety is about 6 lb. (max., 16 lb.), while that of the hill variety varies from 8 to 28 lb. (max., 97 lb.). The Punjab Agricultural Department found bees from the Kulu valley (5000′) to be the best of the hill varieties tried (Simla, Kulu, Kangra, Jeolicote and Kashmir). Kulu bees have also been successfully kept in the plains at Lyallpur.

(*iii*) *A. florea* Fabr., the Little Bee, builds isolated combs in open situations, usually not larger than the outstretched palm. The species is not economically important, and is restricted to Bengal, Assam, Burma, Madras, Malabar, the C.P., and Central India. Only a few ounces of honey are obtained from each comb.

The Dammar Bees belong to the genus *Melipona* or *Trigona*, which consist of a number of species, more common in Burma, Ceylon, Assam and the N. W. F. P. These bees are very small in size, dark in colour, and possess no sting. They build small combs, or rather nests, in the cavities of tree trunks or walls, the mouth of the nest protruding like a funnel. The combs are made with a mixture of earth, wax and a resinous substance which yields 'bees' dammar (*vide infra*). The storage of honey is poor, but the honey is credited with medicinal virtues.

Bees gather nectar and pollen mainly from wild vegetation, and forage all around their hives within a radius of about two miles. In order to enable bees to gather large quantities of honey, pasturage must be extensive and flowers abundant,—a state called 'honey-flow'. In India, honey-flow occurs in spring (Jan.–Apr.) in the plains, and in autumn (Oct.–Nov.) on the hills; a minor honey-flow in the plains occurs in autumn, and on the hills in spring. Rich pasturage exists in the hills and in the forest areas of the plains (*Indian Tr. J.*, 1910, **17**, 212; Ramachandran, *Dep. Agric., Madras, Bull.* No. 37, 1939).

Bees continue to gather and store honey as long as nectar is available, if there is room for storage. A full larder and an overcrowded colony lead to swarming. Some drones are reared and when they begin to fly some queen cells are built for rearing queens. Soon after the first queen cell is capped, suddenly in the middle of a bright day, about half the number of bees in the colony fly out of the hive headed by the queen, and go to a new place to establish a new colony. Fresh combs are built and the swarm soon settles down to normal life. In the parent colony a new queen is born and takes the place of the old queen, and the other queen cells are demolished and their occupants destroyed. Some colonies get into a swarming fever and send out swarm after swarm headed by young queens which are fertilized in new quarters. Colonies thus depleted cannot gather and store much honey.

The worst enemy of the bee colony is *Galleria melonella* Linn., the Wax Moth, the caterpillars of which tunnel through combs, filling them with a white silk and black pellets of excreta. *Achroia grisella* Fabr., the Lesser Wax Moth, does similar damage, but to a much smaller extent. The hives are also attacked by several predacious lizards, spiders and ants (*e.g. Dorylus orienatlis*). Some birds, Bee-eaters and King Crows (Black Drongos) catch them on the wing while out foraging. Indian bees are singularly free from infectious diseases, such as 'Foul brood', 'Sac brood', etc., common in other countries.

In India, honey from wild bees has been used in sacramental rites and in medicine from ancient days, and when available it is prized as food. Bees' venom finds medicinal uses in rheumatism, sciatica, neuritis, and arthritis, the freshly extruded venom being applied to affected parts.

BEE-KEEPING

A crude form of bee-keeping, using earthen pitchers and hollow logs for hiving, has been in vogue in some forest areas and hill tracts (Subramaniam, *Dep. Agric., Mysore, Bull.* No. 10, 1938, 1; Ghosh, *Imp. Coun. Agric. Res., Misc. Bull.* No. 6, 1939). In the Himalayas up to an elevation of about 7000′ open niches in walls of living rooms are used as hives. The yield of honey is poor and it soon ferments into a thin syrup.

In India, the wild Rock Bee has been the principal source of honey and beeswax. Professional honey collectors or wild tribes, burn or smoke away the bees at night, cut their combs, squeeze out honey, and melt the combs for beeswax. In many places in the plains, such honey

collectors also extract honey from the hives of the Indian Hive Bee.

Modern bee-keeping is based on a scientific knowledge of the structure, life-history, habits and habitats of honey-bees, and it began with the invention of the artificial hive in 1789. In India it is only during the last thirty or forty years that attempts have been made to run apiaries on modern lines. Centres of apiculture and schools for training in bee-keeping have been opened in all the important Provinces and States, and an All-India Research Station was started at Lyallpur in 1945. It is reported that there are now in the country over 30,000 colonies of the Indian Hive Bee, in modern hives.

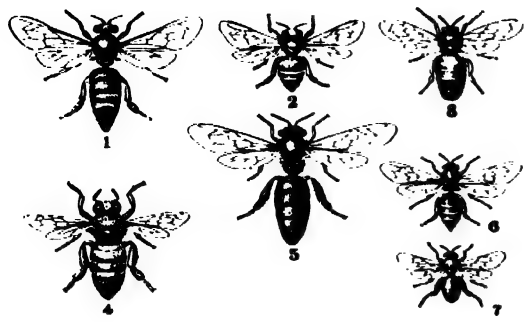
The artificial hive is a miniature house designed for accommodating bee colonies. In its simplest form, it consists of a rectangular wooden box, open both at the top and at the bottom. It has a small opening on the lower side of the front board which serves as an entrance. A few movable frames are fitted into the box to support combs. The lower side of the box rests on a broad wooden piece which serves as the floor and as an alighting board. The top is covered with a movable roof. The essential requirements are the movability of the frames and the provision of space between them, so as to give maximum freedom of movement to the bees. There are different types of bee-hives. Those commonly used are the Langstroth and Newton models.

The other accessories are: (*i*) the artificial comb foundation, (*ii*) the queen excluder, (*iii*) the entrance guard, (*iv*) the smoker, and (*v*) the honey extractor. The artificial comb foundation is a sheet of wax on each side of which are embossed patterns of cells in their natural size and number. The bees build walls using much of the wax from the foundation. This results in considerable saving of honey, since they consume 10–15 lb. of honey in order to secrete 1 lb. of wax. The queen excluder, a perforated zinc sheet, is used to prevent the queen from having access to some combs in the hive in order to secure honey free from brood and pollen. The entrance guard is placed over the entrance of the hive, soon after a colony is hived, so that the queen is imprisoned during the period of the establishment of the colony. It is a small piece of galvanized iron, with a number of holes just sufficient to allow the passage of workers, but not of the queen. The smoker is used to generate a cloud of smoke to subdue bees, when a thorough examination of the hive becomes necessary. The honey extractor is used for the extraction of honey from combs, without damaging the wax-structure. The frames with honeycombs are removed from hives and put into the extractor which empties the cells of their honey by centrifugal force. The empty combs are replaced in hives for bees to re-inhabit.

Successful bee-keeping is dependent on the breed of honey-bees. So far, among indigenous bees, the only species found suitable for domestication is the Indian Hive Bee. It is, however, prone to swarming and is unable to resist the Wax Moth, but it is singularly free from diseases. It is a poor honey gatherer (6–10 lb. per hive) and hill varieties have given more promising results. Further attempts to acclimatize imported varieties (*A. mellifica* Linn. of Europe) are necessary. The Italian bee is a good honey gatherer (35–100 lb. per hive), a prolific breeder and is not inclined to swarming. It has been found successful in America, Africa, Australia and New Zealand.

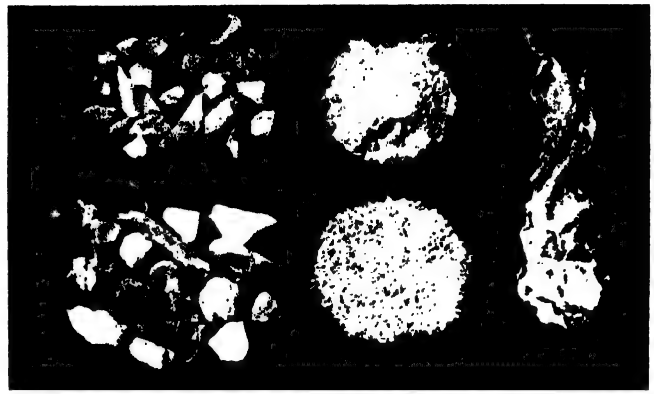
To start a colony, wild combs with their full complements,—queens, workers and drones are removed and transferred to the frames of the artificial hive. Great scrutiny regarding the capture of the queen is necessary as worker bees do not resume their duties in the absence of the queen, and egg-laying. Since locating wild colonies is tedious and difficult for a beginner, natural swarms are trapped during the swarming season, in decoy hives, similar to the earthenware or wooden hives used in rural areas. After a month the decoy hive is taken down from trees and kept in a place, designed for its future location. A week later, the bees are transferred to the artificial hive. It is also possible to hive natural swarms, or to start with nuclei obtainable from apiaries. To popularize bee-keeping queen raising centres supplying such nuclei and standardized appliances will prove helpful.

A keen apiarist should observe closely the various activities of bees. They respond to gentle treatment, and are provoked to sting only on rough and injudicious handling. Sudden jolts and jars and the odour of crushed bees arouse their anger.

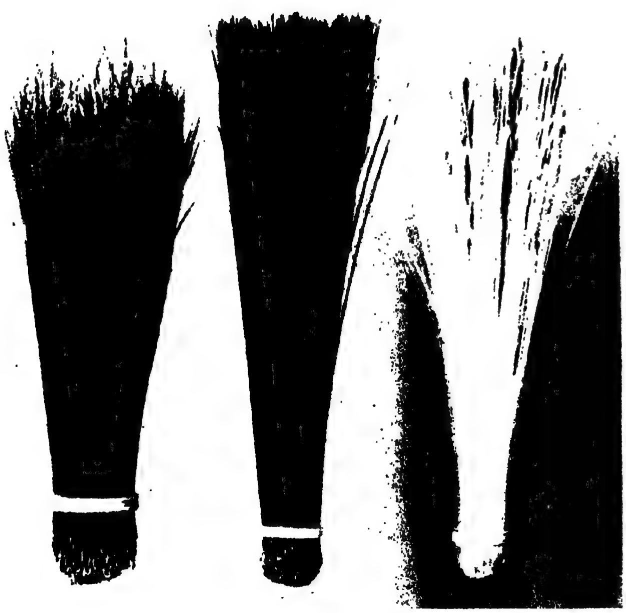


1. BEES

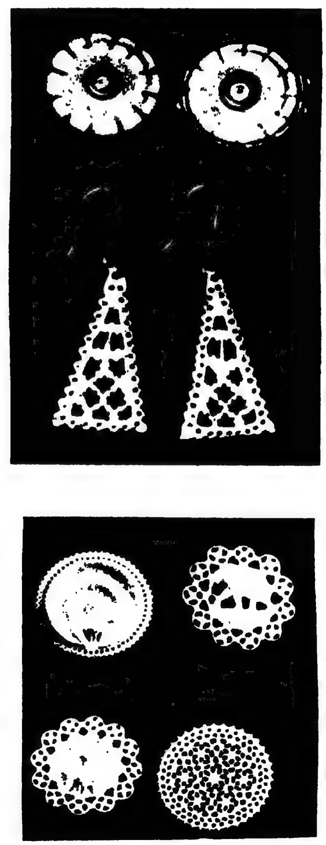
APIS INDICA, QUEEN (1), WORKER (2), AND DRONE (3), WORKERS OF APIS MILLIFICA (4), APIS DORSATA (5), APIS FLORA (6), AND MELIPONA SPP. X 2 (7).



2 CRUSHED BONES (*Left*); BONE MEAL AND BONE GRIST (*Centre*); & BONE SINEWS (*Right*).



BRISTLES BEFORE DRAGGING (*Left*); & DRESSED BRISTLES (*Centre* & *Right*).



4. BONE ORNAMENTS

Examination of hives should be on bright mornings, and during honey season, when the workers are busy. A beginner is advised to wear gloves and a veil when manipulating hives. Smoking should be resorted to, as this subdues the bees; but with discretion, as misuse may drive away the entire colony.

The sting has always been a discouraging factor in bee-culture. The bee-keeper usually develops a sort of immunity to the toxic effects of the poison. When stung, it is advisable not to rub or scratch, as the smell of venom attracts more bees. It is better to withdraw from the hives, and to remove immediately the sting with a knife or finger-nails, and then to mask the smell of the poison by applying the juice of green leaves or tincture of iodine. The application of ammonia or alternate hot and cold fomentation is recommended.

The hives should be spaced at least 6′ apart and should be capable of being manipulated from behind. They should be placed, preferably facing east, in a dry sheltered spot and in the vicinity of pasturage. Sunlight induces the bees to start their daily work early.

Ordinarily, bees start their activities soon after hiving. In case the combs have no stored-up honey, the bees should be fed on sugar syrup or dilute honey. It is advisable not to disturb freshly hived colonies for at least a fortnight, except for cleaning the floor-board of the hive. The only sure index of successful hiving is the prolific egg-laying of the queen. Adverse inexplicable tendencies, such as the desertion of hives and absconding are often met with.

Bees store honey in cells and remove excess of moisture by a process of natural ripening, and seal cells filled with ripened honey using wax. Combs can be taken off for extraction when about 75% of cells are found sealed. After driving off bees the cells are uncapped by cutting with a hot knife and honey is separated using the honey extractor. Excess of moisture can be removed from unripened honey by keeping it warm (140°–150°F.) for about half an hour. But it should not be heated too long above 150°F. as it begins to lose its diastase content very rapidly.

Bee-keeping is a profitable subsidiary occupation for agriculturists, and may be practised also as a useful hobby. Initial expenses and maintenance charges are fairly low. An economic unit which can be managed by a single farmer, is said to consist of six hives, yielding per annum about 60 lb. of honey and a net profit of *ca.* Rs. 48 (Sankaran, *Indian Fmg.*, 1946, **7**, 282; Ramachandran, *loc. cit.*).

HONEY

SANS.—*Madhu*; ARAB.—*Asal*; PERS.—*Shahad*; HIND. & BENG.—*Madhu*; GUJ. & MAR.—*Madh*; TEL.—*Taene*; TAM. & MAL.—*Taen*; KAN.—*Jenu tuppa*.

Raw honey extracted from hives is strained through a sieve, or better through muslin, and allowed to ripen in tanks for about 24 hours, when all the air bubbles contained in it escape. Otherwise they form scum on the surface. Large honey-packing stations use vacuum settling tanks.

Honey varies in colour from straw-yellow to reddish-brown and even black, and also in flavour, due to differences in pasturage. Blending yields products of uniform colour and flavour. In cold season, the different varieties are warmed to facilitate mixing. After blending honey is graded according to its colour, flavour, aroma and density, and packed in tins, earthenware jars or bottles.

In cold weather honey begins to granulate—sucrose and dextrose separate out in crystalline form, and these redissolve on warming. Granulation also causes 'frost'—honey shrinks away from the sides of the jar leaving air spaces which appear as a frost. This also detracts from its appearance.

In Europe and America, section honey, *i. e.*, portions of combs filled with honey, are also marketed, but to a much smaller extent than extracted honey, on account of its higher cost.

Honey, owing to its high price, is frequently adulterated by the addition of sugar syrup or invert sugar. These affect both its aroma and flavour.

Honey (sp. gr., 1·359–1·361) is a viscid fluid about 97% as sweet as sucrose (Jacobs, I, 818), and its storage temperature lies between 36° and 45°F. (*ib.*, II, 12). It is generally laevorotatory, and contains chiefly dextrose and levulose, a little sucrose and small amounts of minerals, acids, and colouring and flavouring materials. Its composition varies according to pasturage.

COMPOSITION OF HONEY (PER CENT.)

	Indian honey*	English honey†	American honey‡
Moisture .	14–24	17·2	17·7
Dextrose .	23–36	34·0	34·0
Levulose .	30–44	39·1	40·5
Sucrose . .	0·4–6	0·4	1·9
Dextrin and gums	0–7	0·45	1·5
Ash . .	0·18–1	0·75 (mineral salts)	0·18
Miscellaneous: acid, pollen grains, beeswax, pigment, etc.	0·1–7	8·1	4·1

* Daji & Kibi, *Indian Bee J.*, 1940, **2**, 62 ; 1941, **3**,43 ; † Rep. Marketing of Honey and Beeswax in England and Wales, 1931, **9** ; ‡ *Indian Fmg.*, 1942, **3**, 333.

Honey was the only sweetening agent in the West before the advent of cane and beet sugar. Since it contains only simple sugars it is valuable when a supply of carbohydrate in an easily assimilable form is required (cal. val., 319 cals. /100 g.). It contains : vitamin B_1, 6 μg. ; vitamin B_2, 60 μg. ; vitamin C, 5 mg. ; nicotinic acid, 32 mg./ 100 g. (Heinz Co., Nutrit. Charts, 1942, 29).

Honey forms the basis of many preparations in Indian medicine. Honey, especially lotus honey (from bees feeding on lotus flowers), is useful in eye troubles. Being a demulcent, it relieves dryness and is prescribed for sore-throat, coughs, colds and constipation. Heated honey or honey mixed with hot liquids can be given both as an emetic and as an enema. *Mel depuratum* B.P. is purified honey adjusted to a specific gravity of 1·36 (15·5°/15·5°) by the addition of distilled water. The I.P.L. recognises honey from *A. dorsata* and from other indigenous species of *Apis*.

It is estimated that about 5 million lb. of honey are produced annually in India (*Indian Bee J.*, 1947, **9**, 20). Several organisations, both official and non-official, are processing crude honey, and marketing it.

The following are the prices (1947)* of different varieties of honey marketed in India :

Source	Rs. per lb. Wholesale	Rs. per lb. Retail
A. dorsata (wild) .	0 6 0	0 12 0
A. indica (wild) .	0 12 0	1 8 0
A. indica (apiaries) .		2 0 0 – 2 8 0
A. mellifica (imported)		1 4 0 – 1 12 0

* Muttoo, Editor, *Indi*

The price of Indian honey is much higher than that of imported honey. This stresses the urgent need for reorganization of honey production and marketing in India.

BEESWAX

ARAB.—*Shama* ; PERS., HIND. & BENG.—*Mom* ; MAR.—*Mema* ; GUJ.—*Min* ; TEL.—*Mynamu* ; TAM. & MAL.—*Meshugu* ; KAN.—*Mena*.

The hives of Rock Bees form the main source of beeswax in India. The right of collection is leased out to contractors by Forest Departments. The largest wax producing countries in the world are British East Africa, Sudan and Nigeria (*Bull. imp. Inst., Lond.*, 1935, **33**, 49). Cappings of hives of domesticated bees collected during honey extraction, and broken and discarded combs in apiaries are the other sources of wax.

Wax is extracted by heat or pressure. When combs are boiled with water, wax melts and rises to the top and solidifies on cooling. Large apiaries employ mechanical appliances. Crude wax is melted by means of steam and freed from solid impurities, etc. On cooling, the molten material solidifies and is ready for the market.

Beeswax is generally lemon-yellow to orange in colour, and light-coloured samples are preferred. Good quality unadulterated beeswax is of uniform quality, clean in appearance, and free from impurities such as dead bees, etc. It is liable to adulteration, the common adulterants being mineral matter, flour, starch, tallow, Japan wax, stearic acid, paraffin and other waxes.

For the manufacture of candles and certain other purposes bleached wax is required. Beeswax is generally bleached by shredding it into thin ribbons and exposing them to strong sunlight. Since bleaching takes place only at the surface, the wax is repeatedly melted, converted into fresh ribbons and exposed to the sun. Beeswax may also be bleached by hydrogen peroxide or chromic acid (potassium dichromate and sulphuric acid). But chemically bleached beeswax is not suitable for all purposes (*Bull. imp. Inst., Lond., loc. cit.*).

Unrefined beeswax is a non-crystalline solid with an agreeable odour of honey and no taste. It is soft to touch, and brittle, but becomes plastic when warm, and on cooling gives a granular fracture. It is insoluble in water, sparingly soluble in cold alcohol and readily soluble in boiling alcohol, ether, chloroform, carbon tetrachloride, and in fixed and volatile oils.

higher alcohols and hydrocarbons. Indian beeswax contains nearly the same amount of myricin, but much less free cerotic acid, and hydrocarbons. Further, ceryl alcohol is the only free alcohol present in it (Rangaswami, *Indian J. Pharm.*, 1944, **3**, 122).

Unrefined wax is used for wax-comb foundations of artificial hives. It is also used in furniture and floor polishes, in the manufacture of electrical insulators, and in preparations for dressing and waterproofing leather goods. Beeswax is more adhesive than paraffin wax and it is used for grafting, sealing and sewing waxes. It is required by goldsmiths for making moulds, and in brass and copper foundries. Large quantities are also used for making models. During the War a solution of beeswax in castor oil was used as a protective coat against mustard gas.

Refined wax is used in the preparation of cosmetics, ointments, suppository bases, plasters and

ANALYTICAL CONSTANTS OF BEESWAX FROM DIFFERENT SPECIES OF INDIAN BEES*

	A. dorsata	*A. indica*	*A. florea*	*Trigona sp.*
M. p.	60–67°	62–64°	63–68°	66–76°
Acid val.	4·4–10·2	5·0–8·8	6·1–8·9	16·1–22·9
Sap. val.	75·6–105	90·0–102·5	88·5–130·5	73·7–150
Ester val. (sap. val.—acid. val.)	71·2–94·8	85·0–93·7	82·4–121·6	57·6–127·1
Ratio No. (ester val./acid val.)	9·29–16·1	10·64–17·0	13·5–13·66	3·57–5·4
Iod. val.	4·8–9·9	5·3–9·2	6·6–11·40	30·2–49·6

* Ex Hooper, *Agric. Ledger*, 1904, **11**, 106.

In general, Indian beeswax resembles Chinese and Japanese waxes (*Bull. imp. Inst., Lond.*, 1922, **20**, 155), and like them it has low acid value and high ratio number.

The principal constituents of European wax from *A. mellifica* are myricin (myricyl or melissyl palmitate, 86–92%), free cerotic acid, $C_{26}H_{52}O_2$ (12–14%), and small quantities of melissic acid,

surgical dressings. A mixture of 9 parts of beeswax and hard paraffin, in which sawdust has been incorporated, is known as Columbia wax and is used for moulds in the application of radium needles (B.P.C.). The manufacture of candles for use in churches is an important aspect of bees wax industry. These contain 25–95% of bees wax.

Two grades of beeswax are used in pharmacy: yellow beeswax (*Cera flava*), and white beeswax (*Cera alba*), the bleached variety. B.P. beeswax is mainly from *A. mellifica*, while the wax from *A. dorsata* and of other species found in India is included in the I.P.L.

PHARMACOPOEIAL SPECIFICATIONS FOR BEESWAX

	B. P.	I.P.L.
M. p.	62–64°	61–65°
Acid val.	17–23	6–7
Sap. val.	87–103	86–102
Ester val.	70–80	80–95
Ratio No.	3·3–4·0	11–16

Exports of beeswax are not classified separately in the *Annu. Statt. Sea-borne Tr. India*, but are included under the heading, 'waxes other than paraffin wax', and it is presumed that most of this refers to beeswax.

AVERAGE ANNUAL EXPORTS OF WAX OTHER THAN PARAFFIN

Quinquennium ending	Qty. (Cwt.)	Val. (Rs.)
'38–39	4,025	1,98,652
'43–44	3,634	3,76,393
In '44–45	750	1,47,340
,, '45–46	1,209	1,77,409

Considerable quantities of 'waxes other than paraffin wax' are also imported into India (average annual imports during the decennium ending '43–44, 13,000 cwt., valued at Rs. 3·45 lakhs), chiefly from Burma, the U. S. A., the U. K., Germany, Japan and Sumatra. But it is not clear if beeswax forms the principal item included under this heading.

BEES' DAMMAR

Pwe-nyet or bees' dammar is a peculiar waxy resinous substance secreted by bees of the genus *Melipona* or *Trigona*. It is one of the minor forest products of Burma. Dammar bees collect resin from several species of resin-bearing trees and deposit it in their nests. Each hive yields about half a pound of resin.

Pwe-nyet, as sold in the bazaar, consists of irregularly shaped lumps varying in colour from light yellow to dirty black. It is tough and plastic and softens readily on warming. Fresh samples have a faint aromatic odour. On exposure it becomes hard, dry, and brittle. According to Hooper (*Agric. Ledger*, 1908-09, **15**, 49), best quality *pwe-nyet* has the following constants: solubility in alcohol, 86·2%; sap. val., 52·2; iod. val., 137·1; ester val., 23·9; and acid val., 28·3. It is similar in composition to the dried resin of *Dipterocarpus tuberculatus*.

Pwe-nyet is mostly used for caulking boats. For this purpose it is first boiled with water and then kneaded with a certain amount of petroleum until it obtains the consistency of putty. It may also be employed as a waterproofing material, and as a cement.

Beet root, see **Beta vulgaris**

Beetle, Blistering—, see **Cantharidin**

BEGONIA Linn. BEGONIACEAE

D. E. P., I, 438; Fl. Br. Ind., I, 635.

A large genus of succulent herbs or undershrubs including about 750 species, distributed over the warm and moist parts of the world. Numerous horticultural varieties have been raised by hybridization. They are valued chiefly for their ornamental foliage: *B. rex* Putz., *B. griffithii* Hook., etc. *B. semperflorens* Link & Otto also bears beautiful flowers.

The leaves of many Begonias, when fresh, have a pleasant acid taste and are eaten as pot-herb. The juice of several species is poisonous to leeches and may be used for killing them when found in the nostrils of animals (cf. *Anagallis arvensis* Linn.).

BEILSCHMIEDIA Nees LAURACEAE

A genus of about 40 species of large or medium-sized trees, found in India and south-east Asia. Some yield useful timber.

B. roxburghiana Nees

D E. P., I, 438; Fl. Br. Ind., V, 121.

ASSAM—*Serai-guti*; BURM.—*Shawdu*.

An evergreen tree, widely distributed in Kumaon, Oudh, eastern Bengal, Assam, Western Ghats, Burma and Yunan.

The wood is white, streaked with red, moderately hard and even-grained (wt., 36–39 lb. per c. ft.) (Gamble, 559). In Assam, it is used for making boats, and in Darjeeling for constructions and tea-boxes.

B. sikkimensis King ex Hook. f.

Fl. Br. Ind., V, 122.

NEPAL—*Tarsing*.

A tall evergreen tree, distributed in Sikkim and Bhutan (5,000–6,000′).

The wood is brownish-white and soft (wt., 35–36 lb. per c. ft.). It is used for constructions, tea-boxes, etc. (Troup, III, 785).

Bel, see **Aegle marmelos**

BELAMCANDA Adans. IRIDACEAE

A monotypic genus confined to east Asia.

B. chinensis DC. LEOPARD LILY

Fl. Br. Ind., VI, 276.

ASSAM—*Surjakanti*; CHINESE—*Sheh Kan*.

A herb, with a creeping rhizome, found wild in China. It is also grown all over India.

In Chinese materia medica, *Sheh Kan* is the chief remedy for tonsillitis. It is also given in chest and liver complaints and is added to tonics. It is reported to possess purgative properties (Burkill, I, 315).

The glucoside, shekanin, m.p., 257°, isolated from the rhizomes of this plant, has been proved to be identical with tectoridin, $C_{22}H_{24}O_{11}$, from *Iris tectorum* Max. (Mannich, Schumann and Lin, *Chem. Abstr.*, 1937, **31**, 7059). Wang and Hu, who had obtained a neutral crystalline substance, m.p., 63–65°, have recently reported the isolation from the roots of another colourless crystalline glucoside, belamcandin, m.p., above 300°, which on hydrolysis yields pentahydroxy monomethoxy isoflavone (*J. chem. Soc.*, **1944**, 307).

Bell pepper, see **Capsicum annuum**

Belladona, see **Atropa belladona**

Bengal cardamon, see **Amomum aromaticum**

BENINCASA Savi CUCURBITACEAE

A genus of two species of climbers, distributed in Asia, of which *B. hispida* is found in India.

B. hispida (Thunb.) Cogn. Syn. *B. cerifera* Savi THE ASH GOURD

D. E. P., I, 439; Fl. Br. Ind., II, 616; Pl. XXX, 1.

SANS.—*Kooshmanda*; PERS.—*Pazdaba*; HIND.—*Petha*; BENG.—*Chal kumra*; GUJ.—*Bhuru kohlu*; MAR.—*Kohala*; TAM.—*Pushani kai*; TEL.—*Budida-gummadi*; KAN.—*Budagumbala kayi*; MAL.—*Kumbalangai*.

An extensive, trailing or climbing herb. Its fruit is a broadly cylindrical or spheroidal gourd, 1–1·5′ long, with white flesh, containing numerous, much compressed, and margined seeds. The bluish-white waxy bloom which exudes from its surface can be collected.

The plant is probably a native of Malaysia, but is now found throughout the tropics. It is cultivated for its fruits throughout the plains of India, Burma and Ceylon, and on the hills up to 4,000′. In the plains seeds are sown during Feb.–Mar., and on the hills in Mar.–May. The vines are trained on to the roofs of huts in villages. The fruits are ready in 3–5 months.

The fruit has the following composition: moisture, 96; protein, 0·4; fat, 0·1; carbohydrate, 3·2; mineral matter, 0·3%; and vitamin B_1, 21 I. U./100 g. (*Hlth. Bull.*, No. 23, 1941, 32). The young fruit is used as a vegetable and made into curries, while the ripe fruit is cut into pieces and candied (*petha*). The seeds yield a pale yellow oil. They are fried and eaten.

The seeds are said to possess anthelmintic properties and the oil is equally efficacious. The juice of the ripe fruit is considered useful in haemoptysis and other internal discharges, and beneficial in phthisis (Kanny Lall Dey, 45).

BENTONITE

JODHPUR—*Seri matti, mait*; KARAULI—*Mund-dhoni matti*; KASHMIR—*Serati matti*.

Bentonite, a clay formed by alteration of volcanic ash, is an extremely fine-grained and very highly absorbant material. It contains 75% or more of crystalline clay-like minerals, montmorillonite, $(Ca, Mg) O, Al_2O_3, SiO_2, nH_2O$, and beidellite, $Al_2O_3.3SiO_2.nH_2O$, which possess bleaching characteristics. The so-called 'bleaching clays' are either activated bentonites or fuller's earths. When placed in contact with water, bentonite swells considerably forming a slippery gelatinous mass resembling soft soap. Hence it is also called 'mineral soap' or 'soap clay'.

Bentonites may be white, cream, yellowish-green, olive-green, grey, pink or brown. On exposure to moisture almost all bentonites assume a slightly darker shade. Indian bentonites (sp. gr., 2·13–2·80) show a conchoidal or sub-conchoidal fracture, and can be easily cut with knife into thin shavings. Freshly cut surfaces show waxy lusture and are generally soapy to touch.

The chemical composition of Indian bentonites varies within wide limits (Sen Gupta, *J. Indian chem. Soc.*, 1938, **15**, 560). The commercial importance of bentonites depends more on their physico-chemical properties (base-exchange capacity, pH value, swelling power, setting time, gel volume, etc.) than on their chemical composition. Some of the properties of Indian bentonites have been investigated by several workers, notably Mukherjee and Sen Gupta (*Sci. & Cult.*, 1940, **6**, 368; *Nature, Lond.*, 1940, **145**, 971), Mitra (*Bull. Indian Soil Sci.*, No. 4, 1942), Taylor, Hoon and Ahluwalia (*J. Indian chem. Soc., Industr. & News Edn.*, 1941, **4**, 29).

DISTRIBUTION

Bihar: Bentonite, resembling the material from Kashmir, has been recently discovered at Tinapahar in Rajmahal Hills of Santhal Parganas, and is being worked on a small scale.

Kashmir: At Bhimbar (32°59′ : 74°5′) in Mirpur dist., bentonite occurs as a long narrow outcrop associated with rocks belonging to the Upper Siwaliks. Middlemiss (Miner. Surv. Rep. Jammu & Kashmir, Non-metallic Miner., 1930, 32) has recorded that the deposit varies from 1–4′ in thickness, generally not exceeding two feet, out of which good quality white bentonite is only 2–6″. The deposit has been followed over a distance of more than 30 miles from near Bhimbar to Thandi Choi (32°55′ : 74°30′), and dips at 15–25° to the south and SSW. It has been opened up near the edge of hills close to Bhimbar, which is 25 and 29 miles respectively from Lala Musa and Gujrat on the N. W. Ry. Another deposit which has been traced for a distance of over 20 miles near Jammu may be the continuation along the strike of the Bhimbar deposit. In both Bhimbar and Jammu areas, another horizon of bentonite can be followed about 110–170′ above the main deposit.

Punjab: Recently the Kashmir Chemical Industries have opened up a deposit situated about 4 miles SSW. of Rohtas (32°58′ : 73°35′) in Jhelum dist. It occurs as a thin band in light-coloured micaceous sandstones (probably Middle Siwaliks) dipping WNW. at 50–60° on the north-west flank of the complex and tightly pinched Jogi Tilla structure. The total thickness of the argillaceous band is 3–4′, out of which high grade cream-coloured or white bentonite forms the lowest 3–6′, and this is covered by 1–1½′ of greenish-grey to dark-grey bentonite. The white variety is placed in the market under the trade name 'Tulison bentonite'. This deposit has been followed along the strike for about 1½ miles, and is situated about 9 miles from Dina on the N. W. Ry. The lower portion of greenish-grey bentonite resembles the product at present marketed, except in colour. Bentonite is also reported to occur further south, not far from Jogi Tilla point, and also on the south-east flank of the structure near Dariala (32°54′ : 73° 36′).

Rajputana: In Jodhpur State, in Sheo dist., half a mile east of Akli (26°3′ : 71°14′), a bed of light green bentonite, about 4′ in thickness, occurs under an over-burden of sand 1·5–5′ thick. The bed dips at a low angle to the west, and partial prospecting showed that it is over 4′ in thickness. The material can be extracted in fairly large lumps. About 3 furlongs west of Giral (26°4′ : 71°16′), and near the motor track between Barmer (25°45′ : 71°24′) and Sheo (26°11′ : 71°13′), a deposit of poor quality bentonite has been opened up in a few small pits.

Half a mile south of Hathi-ki-dhani and about 2 miles west of Sheo, bentonite outcrops occur over an area 650′ in length and 50–150′ in breadth. The deposit is about 20′ in thickness and dips 10–15°. Bentonite from this source is light-grey or greenish grey in colour, but the material from the southern-

most portion of the outcrop is stained yellow, especially near the top and the bottom of the bed. Except for a small percentage of sand, the material is free from objectionable impurities such as gypsum carbonaceous matter, etc. The lowest layer, however, contains some saline matter, which has to be discarded or left out in quarrying. Owing to its occurrence in hillocks and the presence of only a small amount of overburden, this deposit is readily workable.

In Malani dist., near Barmer railway station, a deposit of bentonite, over 5′ thick, occurs under an overburden of 4′ of sand and silt. The bed dips 15–20° to the south-east and has been traced along the strike for about 70′. Bentonite from this source is iron-stained along joints, and is associated with lenticular bands of selenite, and appears to be of poor quality. Recently three more deposits of superior quality bentonite have been located within a radius of three miles from Barmer. These deposits are covered by a thick overburden of sand, and have not been prospected so far.

A deposit of bentonite over 6′ in thickness occurs on the western slope of an elongated hillock, situated about a mile east of Bhadres (25°53′ : 71°18′). It has been followed for about 300′. The material can be excavated in large lumps. Another deposit 4–5′ in thickness occurs about a furlong south of the village, but appears to be of inferior quality.

West of Dodra tank, situated two miles north-east of Bisala (25°55′ : 71°14′), a deposit of bentonite over 7′ in thickness and dipping at 20° to the north-east occurs under 3½′ of overburden of sub-recent breccia. The material from this source contains some lenticles of limonite in the lower portion, and needs some hand-picking.

Half a mile to the SE. of Maobar Kalan (25°43′ : 71°25′) and close to the path to Sheokar (25° 43′ : 71°30′) bed of chocolate-coloured bentonite over 5′ thick, occurs under an overburden of sand, 2½′ or more in thickness. Although the material can be excavated in fairly large lumps, its unattractive colour and other physical properties suggest that it is of inferior quality.

East of Nimli Nadi, within the limits of Hapa-ki-dhani (25°50′ : 71°22′), a 5′ bed of poor quality bentonite occurs under 5′ of alluvium and soil. A deposit, containing bands of clay-ironstone and calcareous matter, occurs about 1½ miles west of Sonri (25°59′ : 71°16′).

In Karauli State, a deposit of bentonite-like clay, 1–2′ thick, occurs over an area of about 60 acres at Dargama (26°19′ : 77°18′), situated in the western portion of the State, about 30 miles from Karauli, and about 2 miles west of Chambal River. Presumably it occurs in association with rocks of the Vindhyan age. According to the information kindly supplied by the Development Member of the State, the clay bed lies 15–20′ below the surface, and is being worked by pits 3–4′ in diameter. Visitors to the Kaila Devi fair, held in the State every year in March, buy it in small quantities for cleaning hair.

In India, the only deposits about which field data are available are in Rajputana, the Punjab and Kashmir. The Jodhpur deposits occur near exposures of the Malani Volcanic Series. Microscopic examination of Bhimbar bentonite (Kashmir) shows that it contains some devitrified glass. It is probable that like American bentonites, Indian bentonites have been formed by the re-deposition of devitrified and decomposed volcanic ashes, tuffs and lava flows: those of Rajputana, from the Malani rocks; and those of the Punjab and Kashmir, from the Panjal Traps and underlying Agglomerate Slates.

MINING, QUARRYING & TREATMENT

Owing to gentle inclination of the rocks and thick overburden of sandstone, the deposit near Bhimbar (Kashmir) is worked by a number of adits driven into the hill-side. The deposit near Rohtas in the Punjab is worked by shallow inclines and tunnels. In both these areas, due to the thinness of deposits, it has not been found economical to go beyond 20′ from the outcrop.

In Jodhpur, excavation is done by quarrying with pick and shovel. The Hathi-ki-dhani deposit, owing to its occurrence in hillocks, can be exploited entirely by this method. The other deposits will need stripping of overburden; those at Barmer and Bhadres, before long, will probably have to be worked by some underground method.

Indian bentonites receive no treatment at the hands of the supplier, except hand sorting at the mines or quarries, to remove impurities and iron stained material. On the other hand, in the United

States and Europe, bentonite is processed before sale. Processing consists essentially of drying, crushing and grinding bentonite in a hammer or Raymond mill, and air-flotation to about 200 mesh. As freedom from gritty impurities is an essential requisite, some bentonites have to be de-sanded.

To improve their quality, some alkaline-earth bentonites are converted into alkali bentonites by a process of base exchange. This is done by treating them with the requisite quantity of soda ash in the form of a thick slurry in water, or less satisfactorily, by grinding together the two constituents to a fineness of 200 mesh.

For use in refining petroleum products and vegetable oils, bentonite is subjected to acid treatment similar to that for fuller's earth. After drying and fine pulverization, bentonite is agitated with three to four times its volume of 15–25% sulphuric acid (or hydrochloric) in a lead-lined tank, and the mixture is maintained at about 80° for 6 hours. It is then allowed to stand, the acid layer is run off, and bentonite is washed to remove all traces of acid. The slurry so obtained, or bentonite powder obtained by drying and grinding it, is employed in refining oils. By this mild acid treatment, a part of the exchangeable bases is removed and replaced by hydrogen which is responsible for the activation of bentonite. However, if stronger acid is used or if the temperature is allowed to rise higher, the material is likely to deteriorate. The efficiency of most bentonites is appreciably increased by acid treatment, and for refining petroleum products, treated bentonite has been found to be superior to fuller's earth.

It is learnt that recently Messrs. Gillanders Arbuthnot & Company have erected a pilot plant at Izatnagar near Bareilly (U. P.) for the base-exchange treatment of Bhimbar and Rohtas bentonites.

USES

Bentonite finds wide and varied application in America and Europe, chiefly on account of its colloidal absorbing, clarifying and emulsifying properties. It is used in the treatment of drilling muds in petroleum industry ; in filtering and decolorizing oils and fats ; in foundry work ; in softening water and purifying sewage ; as a seal ; to give watertight lining in civil engineering ; in soap manufacture ; and as a substitute for soap in washing. It is also used as a chemically inert filler in various industries, as a base in cosmetics and as a substitute for starch in sizing cloth and in dry cells. It can also be employed for de-inking old newspapers as an absorbent of nitro-glycerine in the manufacture of dynamite ; and in the preparation of surgical dressings, and electrical and thermal insulating materials.

Some Jodhpur bentonites have got good dispersive and emulsifying properties and are suitable for use in the manufacture of distempers. In rainy season, they are used by villagers for preventing the leakage of water through the channels and roofs of their huts. The Kashmir bentonite has been employed as a base in the manufacture of antiphlogistine. Tulison bentonite from the Punjab, along with caustic soda has been employed by some woollen and textile mills near Amritsar for wool scouring, and kier boiling. It has also been used by the Tata Iron and Steel Co. in moulding sands for heavy steel castings. Kashmir and Jodhpur (Hathi-ki-dhani) bentonites also have been used in foundries.

PRODUCTION

The working of Jodhpur bentonites commenced in 1937, and the maximum annual output has been 100–150 tons, but this has substantially decreased since the Bihar material came into the market. It is not known when the working of Bhimbar bentonite commenced, but production in 1938, was only 56 tons. The figures of output from other Indian sources are not available, but that of Bihar bentonite appears to be on the increase.

Production of bentonite amounted to 206 tons in 1943, and 10 tons in 1944. The pre-War price of Jodhpur bentonites varied between Rs. 12/8 and 15 per ton delivered in wagon-load lots at Barmer or Utarlai on the Jodhpur Railway. The cost of mining Bhimbar and Rohtas deposits is comparatively higher, and bentonite from these sources is said to be sold at 3–4 times the price of Jodhpur bentonite.

Benzoin tree, see **Styrax benzoin**

BERBERIS Linn.

BERBERIDACEAE
THE BARBERRIES

The barberries are a genus of spiny deciduous, evergreen shrubs, with yellow wood and yellow flowers. Of some 190 species, distributed mainly in the temperate countries of the world, excepting

Australia and S. Africa, about 13 occur in India, mostly in the Himalayas and in Assam. Four species occur in central and southern India (Nilgiris). One variety of *B. asiatica* Roxb. (var. *clarkeana* C. K. Schneider), occurs in the Parasnath hills of Chota Nagpur. Some species are also found in Ceylon.

The barberries are not easily distinguished from one another and considerable ambiguity still exists, especially as most of them are known by the same vernacular names and possess similar properties. Moreover, the species multiply by natural hybridisation. The five varieties of *B. vulgaris* Linn., as given in the Fl. Br. Ind. are now considered to be distinct species, and *B. vulgaris* Linn. of Europe does not occur in India. *B. nepalensis* Spreng. has now been included in the genus *Mahonia* Nutt. (q. v.).

Berberis roots and bark have long been known in medicine, and have been found to contain alkaloids.

ALKALOIDS FOUND IN DIFFERENT SPECIES OF BERBERIS

Species	Parts examined	Alkaloids present
B. aristata	Root	Berberine (chief alkaloid)
B. asiatica	Stems & root	Berberine, oxyacanthine
B. asiatica, var. *clarkeana*	—	Berberine, hydrastine and neprotine (no oxyacanthine) †
B. bhutanensis Anrendt.	Root	Umbellatine, * oxyacanthine
B. edgeworthiana C. K. Schneider	Stem-bark & root	Berberine *
B. insignis	do	Umbellatine (chief alkaloid)
B. lycium	do	do
B. orthobotrys Bienert ex Aitch.	do	Berberine, oxyacanthine *
B. umbellata	Stem-bark	Umbellatine (chief alkaloid)
B. vulgaris	Root-bark	Berberine, oxyacanthine & berbamine.
B. wallichiana	—	Umbellatine

* Chatterjee, R., unpublished note.
† *Sci. & Cult.*, 1942, **7**, 619.

Berberis is employed in India as bitter tonic, alterative, astringent, stomachic, diaphoretic, gentle aperient, and as curative of piles. Prescriptions of proved utility are described by Koman (1920, 23, 24, 37) and Birdwood (115). Roots of *B. aristata* and closely allied species have been included in the I.P.L. 1946. In Western medicine the barberry (*B. vulgaris* Linn.), is used as a bitter tonic and stomachic and is administered in the form of a tincture.

The herb is prepared for use in a variety of ways. A thick extract is made from root bark, roots, and lower stem wood, by boiling them with water ; this is strained and evaporated, till a dark brown sticky mass of the consistence of opium is obtained. The product is called *Rasaut*, *Rasavanti* or *Rasanjan*. It is bitter, astringent and fairly soluble in water (58·4 82·2%), but only partially so in alcohol. Grewal and Kochar (*Indian J. med. Res.*, 1940, **28**, 463) found that the *Rasaut* from the Punjab market contained 1·67-4·26% of total alkaloids. But some samples with water soluble matter as high as 76% contained no alkaloids. A decoction and a tincture are also obtained from roots and root bark.

Rasaut of high alkaloidal content can be prepared by boiling 20 lb. root chips with water for 4 5 hrs. in a steam-jacketed extractor. The extract is removed and the boiling is repeated 3-4 times till they are completely exhausted. The extract is then filtered and evaporated in a steam-jacketed pan to a thick semi-solid mass. The yield of *Rasaut* from *B. lycium* was 15·4% of the weight of wood taken, and it contained: moisture, 25; and berberine, 9·4%. In crude preparations much of berberine is decomposed due to over-heating (*For. Res. India and Burma*, Pt. I, 1924-25, 100).

Rasaut, mixed with butter and alum, or with opium and lime-juice, and painted over the eyelids, is a useful household remedy in acute conjunctivitis, and in chronic ophthalmia. In Sind mixed with drinking water, *Rasaut* is said to impart a cooling effect (Trotter, 1940, 293).

The practice of washing unhealthy ulcers with *Rasaut* decoction is very old. Varma (*Indian med. Gaz.*, 1927, **62**, 84), and Karamchandani (*ib.*, 558), demonstrated that berberine sulphate cures oriental sore. Das Gupta and Dikshit (*Indian J. med. Res.*, 1929, **16**, 770) and later Gupta (*Indian*

med. Gaz., 1930, **65**, 683) experimentally proved its toxicity (in concentrations of 1 in 80,000) to *Leishmania tropica* —the organism responsible for oriental sore. Three to five injections (1–2 c.c. of a 1–2% solution) given once a week, bring about complete cure (Chopra, Dikshit and Chowhan, *ib.*, 1932, **67**, 194). It has now been tried on a large scale, and proved to be of undoubted value (*Indian med. Gaz.*, 1933, **68**, 265).

The tincture and decoction have long been used and reputed as effective antipyretics and antiperiodics. The Central Indigenous Drugs Comm. (3rd Rep., 1916, 290) after a detailed investigation concluded that the tincture of *B. lycium* is of little use as a remedy in fevers of malarial origin. Chopra *et al.* (*Indian J. med. Res.*, 1932, **19**, 1193) have now shown that berberine has no effect on the signs and symptoms of malarial parasites and is definitely not anti-malarial. But the use of the alkaloid in liberating parasites into the blood stream, thus acting as a provocative agent in the diagnosis of latent malaria has been confirmed.

The drug has been employed as a general febrifuge. Maksym and Nikonorow (*Chem. Abstr.*, 1941, **35**, 3766) have recently found that the roots, stem cortex and berries of *B. vulgaris* of Europe sharply reduce experimentally produced fever in rabbits, and that only some of the alkaloids, but not berberine, present in the plant are responsible for this action.

Chopra *et al.* (*loc. cit.*) have investigated the pharmacological action of berberine. It is found to be only moderately toxic to larger animals. The minimum lethal dose per kilogram body weight for rabbits is about 0·1 mg. It is stated to be mostly destroyed in rabbits, but in man considerable amounts appear in urine, a few hours after oral administration. Gupta and Kahali (*Ind. J. med. Res.*, 1944, **32**, 53) have shown that the action of umbellatine is similar to that of berberine, but more intense. It is also toxic to *Leishmania tropica* and has been tried successfully in the treatment of oriental sore.

Berberine is extracted from the powdered drug with dilute acetic acid. On concentrating the filtered decoction to a thick syrup, and adding to it three volumes of 20% sulphuric acid, the crude sulphate slowly crystallizes out. When this is washed with cold water, redissolved in boiling water, and some alcohol and sulphuric acid added, the pure salt crystallizes out in bright yellow needles.

A yellow dye is obtained from the root and the stem. The colouring matter is reported to exist chiefly in the bark and in the young wood immediately below the bark. The barberry dye has been largely used in tanning and colouring leather. According to Trotter (*loc. cit.*, 280) dyes from the root of *B. aristata* are still used locally by villagers.

Some species are cultivated as ornamental plants for their foliage and flowers.

B. aristata DC. THE INDIAN BARBERRY

D. E. P., I, 442 ; Fl. Br. Ind., I, 110 ; Pl. XXX, 2 ; Bentley and Trimen, Pl. 16.

SANS.—*Daruharidra* ; ARAB.—*Ambarbaris* ; PERS. —*Zarishk* ; HIND.—*Chitra, dar-hald, rasaut, kashmal* ; BENG.—*Darhaldi* ; MAR.—*Daruhald*.

An erect spinous shrub 6–18′ high, often forming gregarious patches, pale yellowish-brown bark, closely, and rather deeply furrowed. Flowers are golden-yellow.

It occurs on the Himalayas from 6,000–10,500′, and also on Nilgiri Hills, and in Ceylon.

The root-bark is rich in alkaloidal content. Ray and Roy (*Sci. & Cult.*, 1941, **6**, 613) have shown that berberine, the principal alkaloid, can be easily obtained from the roots in the form of its salts (yield of hydrochloride, 2·23%, and of sulphate 3%).

The use of the roots as a source of *Rasaut* has been referred to. The dried berries are edible.

B. asiatica Roxb.

D. E. P., I, 44 ; Fl. Br. Ind., I, 110 ; Pl. XXX, 3.

KUMAON—*Kilmora* ; GARHWAL—*Kingora*.

An evergreen erect thorny shrub 4–6′ high, with light brown rough bark. It occurs on the dry outer Himalayas from 2,000–8,500′, and in Assam.

Chopra, Ghosh and Ratnagiriswaran (*Indian J. med. Res.*, 1929, **16**, 770) have shown that the plant contains berberine and oxyacanthine, $C_{37}H_{40}O_6N_2$ (m. p., 208–209°). The total alkaloidal content of roots is 4·0%, and of stem, 1·95%, of which berberine is 2·09 and 1·29%, respectively.

The roots are one of the principal sources of *Rasaut*. The fruit is edible and is sometimes given to children as a mild laxative.

B. insignis Hook. f.

Fl. Br. Ind., I, 111.

LEPCHA—*Timburjhin.*

A large beautiful holly-like bush, 4–6′ high, with well developed internodes. It is a native of the humid forests of the eastern Himalayas from Nepal and Sikkim to Bhutan, between 8,000–10,000′. It occurs plentifully around Darjeeling.

Chatterjee (*Chem. Abstr.*, 1941, **35**, 8208) reports that the stem bark contains 1·52%, and the root 2·5% of total alkaloids, consisting almost entirely of umbellatine, $C_{21}H_{21}O_8N$, m. p., 206–207.

B. lycium Royle

D. E. P., I, 445 ; Fl. Br. Ind., I, 110 ; Pl. XXX, 4.

SIMLA—*Kasmal* ; JAUNSAR—*Chatroi* ; GARHWAL—*Kirmora.*

An erect rigid shrub 4–8′ high, but sometimes as high as 12′. Bark light-greyish and rough. It occurs from Kashmir to Garhwal on the outer north western Himalayas on clearances and along roadsides, between 2,500—8,000′.

Chatterjee (*J. Indian chem. Soc.*, 1942, **19**, 233) includes it among the Himalayan barberries which contain umbellatine as the major alkaloid.

Rasaut was once considered to be a special preparation from this species. Chopra (294) states that most commercial samples are mixtures of *B. lycium* and *B. asiatica*.

B. umbellata Wall.

Fl. Br. Ind., I, 110.

It is a common gregarious shrub 2–4′ high, sometimes attaining 8′. The twigs and young shoots are reddish and glabrous. It occurs on the main Himalayan range and anterior dry ranges (9,000–12,000′), from Kashmir eastwards, and from Kumaon to Bhutan. It forms patches in openings in bluepine forests, or is scattered over bare southern aspects above forest level. It has a stunted growth at high elevations.

Umbellatine was first isolated from the stem bark of this plant (yield 0·68%).

B. wallichiana DC.

Fl. Br. Ind., I, 109.

ASSAM—*Dieng-niang-mat-shynarang.*

Tall, evergreen shrub up to 10′ high occurring in Nepal, Sikkim and Bhutan, at elevations of 8,000–10,000′ and at 5,000′ in Assam.

Oxyacanthine and umbellatine have been found by Chatterjee in its root and bark (*J. Indian chem. Soc.*, 1942, **19**, 233).

BERCHEMIA Neck. RHAMNACEAE

D. E. P., I, 447 ; Fl. Br. Ind., I, 637.

A genus of unarmed shrubs or woody climbers, containing 15 species, mostly confined to eastern Asia. 5 species occur in India. *B. floribunda* Wall. is a pretty shrub or small tree, found in the Himalayas and sub-Himalayan tract (Gamble, 184). *B. lineata* DC. is reported to be medicinal (Kirt. & Basu, I, 587).

BERGENIA Moench SAXIFRAGACEAE

A genus of 10 species of perennial herbs, distributed in East Asia, of which 3 are found in India.

B. ligulata (Wall.) Engl. Syn. *Saxifraga ligulata* Wall.

D. E. P., VI, ii, 484 ; Fl. Br. Ind., II, 398 ; Kirt. & Basu, Pl. 401.

A small plant, growing closely appressed to rocks with leaves about 10″ in diameter. It is found throughout temperate Himalayas from Kashmir to Bhutan, between 7,000–10,000′, and in Khasia Hills at 4,000′.

Its root is said to be used in fevers, diarrhoea and cough. It is reported to contain gallic acid, tannic acid (14·2 %), glucose (5·6 %), mucilage, wax, etc. (Wehmer, I, 423).

The large leaves are used as plates.

BERGIA Linn. ELATINACEAE

Fl. Br. Ind., I, 251.

A genus of herbs and undershrubs, including about 25 species, distributed in tropical and temperate countries. Of these, 4 are found in India. *B. odorata* Edgew., a medicinal aromatic undershrub, is found in western Rajputana, Gujarat, and Sind (Kirt. & Basu, I, 253).

BERRYA Roxb. TILIACEAE

The genus includes 4 species of trees, distributed in the Indo-Malayan Peninsula and Polynesia. *B. cordifolia* is a valuable timber tree.

B. cordifolia (Willd.) Burret Syn *B. ammonilla* Roxb. THE TRINCOMALEE WOOD

D. E. P., I, 447 ; Fl. Br. Ind., I, 383 ; Beddome, Pl. 58 ; Pl. XXVI, 2.

TEL.—*Sarala-devadaru* ; TAM.—*Chavandalai* ; CEYLON—*Halmilla* ; BURM.—*Petwun*.

A moderately large deciduous tree, attaining a height of 60–80′, and a girth of 6′. It is found scattered in mixed deciduous forests, chiefly of the drier type, throughout Burma, up to a height of 3,000′. It occurs in small numbers in the Andamans and Ceylon, and is frequently planted in South Indian forests.

The heartwood is dark red or brown, with darker lines. It has a dull or greasy feel, and when freshly cut, a characteristic odour. It is very hard and heavy (sp. gr., approx. 1·02 ; air-dry wt., 65 lb. per c. ft.). It seasons well and is durable even in exposed situations. It is difficult to saw, but works and machines well and can be brought to a good finish.

On account of its strength and flexibility, Trincomalee wood is much used for the construction of frames, shafts, spokes and the bent parts of carriages and carts. It is also used for spear handles, ploughs and other agricultural implements. It is good for beams, posts and other building purposes. In Madras, it is employed for boat making. It can be made into bent-wood walking sticks. Although very ornamental, it is somewhat heavy for brush-backs and gunstocks. It is not very suitable for furniture, but might be used for small panelling and bent-wood furniture (Pearson and Brown, I, 167).

The tree yields a fibre of minor importance (Trotter, 1940, 233).

BERTHOLLETIA Humb. & Bonpl. LECYTHIDACEAE

Bailey, 1944, 534.

B. excelsa Humb. & Bonpl., a tall handsome tree which yields Brazil nuts, is a native of South America. It was introduced into Ceylon in 1880, and has not proved successful at Bombay. The oleaginous kernels (60–70 per cent. of oil) are much relished as dessert by Europeans.

BERYL

Pl. XXV, 3.

Beryl is an alumino-silicate of beryllium (sp. gr., 1·83), one of the light metals. Its gem varieties, emerald and aquamarine, have been known in India from very ancient times. The element, once considered rare, and still very costly to produce, has become an important alloying ingredient in non-ferrous metallurgy.

Beryl ($3BeO. Al_2O_3. 6SiO_2$; sp. gr., 2·7 ; H., 7·5) is the only important ore of beryllium. It occurs in hexagonal prismatic crystals—refractive indices ω, 1·57–1·60 ; and ξ 1·56–1·59. Dichroism is distinct but not strong. It is green, bluish-green, yellow, or white in colour, usually opaque to transparent. When pure it contains 14·1% BeO (or Be, 5%). The commercial mineral may contain as low as 9% BeO, because of replacement by alkalies.

Emerald is a grass-green gem variety of beryl, and stones with various colours such as pale green, yellowish-green, bluish-green to deep blue are classed as aquamarine. The golden-yellow gem variety is called golden beryl. Bright green emeralds are said to contain 0·1% of chromic oxide to which the green colour is attributed. The pink or rose-red variety of beryl (morganite) is said to owe its colour to a small amount of caesium.

Of gem varieties, emerald of good colour and without flaws is the costliest precious stone. Flawless stones of 5–10 carats are very rare and fetch fancy prices. Aquamarine, pink and yellow (golden) beryls are more common than emerald and are comparatively cheap. These stones are cut in brilliant fashion, or step cut. The darker stones are cut and engraved. Aquamarine is also cut into pendants.

Beryllium minerals are found mostly in pegmatites, granites and syenites. They are also found occasionally in gneisses and mica-schists. When occurring in pegmatites, the crystals may attain large size and good crystal form. Beryl crystals are sometimes of huge size, 2–3′ in diameter, and several feet in length and weigh many tons. Crystals grown in cavities in the mother-rock are frequently quite transparent and of gem quality. Whereas common beryl is found in pegmatites, emerald occurs in schistose rocks and limestones, in close proximity to granite intrusions.

DISTRIBUTION

(Krishnan, *Rec. geol. Surv. India*, 1942, **76**, *Bull. Econ. Miner.*, No. 13).

Beryl is widely distributed in pegmatites associated with granites in various parts of India, particularly in Rajputana, Bihar and Madras.

Bihar : The mica-bearing pegmatities of Gaya and Hazaribagh contain beryl in several places. Its presence has been noted in a dyke crossing the Tendwaha river, south of Mahabar hill in Hazaribagh dist. The mineral is fairly common in the Kodarma forest, and Jorasemar and Gawan in Hazaribagh, where it is associated with tourmaline, garnet, etc. Beryl has also been found at Mahesri in Monghyr dist. Single crystals weighing several maunds have been collected occasionally from the mica mines of Bihar.

Burma : In the Mogok Stone Tract, beryl has been found in *byon* or gem gravels, and in the great pegmatite dyke at Sakangyi on the way to Mogok. Beryl is known to occur in granite and pegmatite at Byingyi in Yamethin dist., where it is associated with wolfram and molybdenite, and in the Dawna mountains of Amherst dist.

Ceylon : Aquamarine occurs in the gem gravels of Ceylon along with other gem stones, in alluvial deposits, and also in its original matrix, *i.e.*, pegmatite containing aquamarine and moonstone.

Kashmir : Pegmatites in Baltistan contain beryl and aquamarine, together with tourmaline, garnet and muscovite. Gem quality acquamrine up to 3″ in length is found in drusy cavities, whereas ordinary beryl may be up to 6″ in length. This aquamarine is light blue and occasionally contains patches of violetish-blue colour. North of Kaghan village, the granites and pegmatites intruded into the Salkhala series show beryl, tourmaline, flourite, corundum, etc.

Madras : The mica pegmatites of Nellore dist. are known to contain some beryl. The chief occurrences are near Gudur (14° 9′ : 79° 51′). Small quantities of beryl have been obtained from some of the well known mica mines in this neighbourhood, but no attempt has been made so far to separate and market the mineral. The beryl is blue, green, yellowish-green, yellow or white in colour and contains, on an average, about 12·5–13% BeO. Crystals up to 3′ in length are known.

The pegmatites near Padayur or Pattalai (11° 3′ : 77° 33′) in Coimbatore dist. are said to have been mined about a century ago for aquamarine. The mineral is occasionally found in the graphic granite of Sivamalai in the same district. Small crystals have been found *in situ* in mica-bearing pegmatite at Karaiyaur (11° 35′ : 77° 56′) and Kurumbapatti (11° 35′ : 77° 52′), a few miles north-east and north, respectively, of Sankaridrug in Salem dist. and at Vairamangalam near Bhavani in Coimbatore dist.

Mysore : In a pegmatite at Yediyur, near Bangalore, some opaque bluish-green crystals of beryl have been found in a 2′ quartz vein. The crystals are very sporadically distributed and the quantity obtained in a trial pit sunk on the reef to a depth of 25′ was less than a cwt. Associated with common beryl are found some pale bluish and yellowish-green crystals, translucent to transparent in parts. From these, small gems have been cut (*Quart. J. geol. Soc. India*, 1942, **14**, 175 and 181).

N. W. F. P. and north-western Himalayas : There are numerous granitic intrusions in the garnetiferous schists close to the Afghan frontier. One of these intrusions at Sirwig-o-gaz shows fairly abundant beryl crystals some of which are of gem quality (aquamarine), the major part being green and blue beryl full of cracks. The Central Gneiss of Sutlej and Chandra valleys shows numerous veins of albite-bearing granite and pegmatite, in which beryl is frequently seen. Their presence in the Shipki Pass and in the Mount Kamet region has also been noted.

Orissa : Crystals of beryl were found associated with the mica pegmatite at Burhiakata (21° 18′ : 84° 8′) in Sambalpur dist., and Nangullia Bera (20° 48′ : 83° 11′) and Baideswar (20° 21′ : 85° 23′) in Cuttack. The Burhiakata occurrence is unusual, as the amount of beryl although small is larger than is found in any of the Bihar mica mines (Econ. Geol. Orissa, Officers geol. surv. India, 1943, 121).

Rajputana : The most productive occurrences are in Ajmer-Merwara and Mewar (Udaipur State), which have been described by Bhola (*Trans. Min. geol. Inst. India*, 1935, **29**, 127).

In Ajmer-Merwara, at Bisundni (25° 44′ : 75° 12′) near Deoli cantonment, there is a coarse pegmatite, over 1,000′ long and 75–100′ wide. In this, numerous crystals of beryl of large size are found, some of them being up to 4′ across and 20′ long. A single crystal is known to have yielded as much as 20 tons of beryl. This deposit gave about 1,000 tons of beryl in '33 and '34. Some transparent pale green beryl of gem quality and some good rose quartz are also found here. At Tehari (26° 24′ : 74° 58′) there is a lenticular mass of pegmatite, measuring 130′×40′ in the thickest part, and dipping vertically in a country of mica-schists. Beryl crystals are up to a foot in thickness, and 5′ in length. Up to 1934, this deposit had produced about 16 tons of high grade beryl. Some books of amber-coloured mica were also found here.

A pegmatite near Lohagal (26° 31′ : 74° 42′), showed the presence of beryl, up to 3′ in length and 6″ across, but the yield was not good. A pegmatite body at Kharwa (26° 12′: 74° 28′) contains beryl in the south-western portion in association with microcline. About 6 tons of beryl were recovered as a by-product of felspar mining. Another pegmatite at Shokla (26° 12′ : 74° 55′) showed a few large beryl crystals in association with pink felspar, but after yielding about 4 tons of beryl, it became barren below a depth of 6′. In recent years, an old mica mine at Gordan (25° 43′ : 75° 10′) has also yielded some beryl and mica. Some beryl occurs about two miles west of Sarwar (26° 4′ : 75° 31′), on either side of the Nasirabad-Deoli road.

In Mewar State, large beryl crystals, up to 18″ across, occur in a pegmatite covering an area of 600′×500′ near Deora (25° 32′ : 75° 10′). The crystals are scattered in the patches of pegmatite. Near Jamoli, a pegmatite, 500′×280′, forms a hill, on the northern and eastern slopes of which are scattered beryl crystals, some of which are up to 2¼′ thick. This occurrence was discovered in 1935 and the locality is about 40 miles from the railway. There are also several other pegmatites in this State, some of which presumably contain beryl, for there has been some production (also of gem quality material) during the last 3 or 4 years.

Other localities in Rajputana are Ninjar (27° 26′ : 76° 31′), Rajmahal (25° 31′ : 75° 34′), near Toda Rai Singh (26° 2′ : 75° 35′), and between that place and Tonk. Some beryl has also been obtained from Para (25° 33′ : 75° 4′) and from Taragarh hill near Ajmer.

All the beryl so far exported from India has been obtained from Rajputana, mostly from Ajmer-Merwara and Mewar. The mineral from Bisundni contains about 13% BeO, while that from other localities in Rajputana is said to be even richer.

MINING, PREPARATION AND USES

Beryl is scarcely ever mined independently and it is usually a by-product in the mining of felspar, mica, lithium minerals, etc. But much of the Indian output is from direct mining. As the mineral occurs in the form of coarse crystals it is hand-picked after breaking up the matrix.

It is reported that the froth-flotation process has been adapted to the concentration of beryl, if it occurs in a granular form with other minerals. So far it has not been necessary to use this process in India, as enough clean mineral is available in coarse form.

Beryl is employed for the extraction of beryllium oxide and beryllium. The metal is obtained by the electrolysis of a molten bath of either beryllium oxide and beryllium fluoride, or beryllium chloride and sodium chloride. More commonly, its copper alloy is prepared directly as *misch metal* by the addition of finely divided copper to fused beryllium oxyfluoride, during electrolysis. The Brush Beryllium Co., U. S. A., have developed a chemical process for preparation of the metal and its alloys. The ore is dissolved in strong sulphuric acid and the sulphate formed is converted to the oxide in a rotary kiln at a temperature of 1450°. The oxide is then reduced to the metal by carbon or hydrogen. The alloys are made by treating beryllium oxide with carbon in an arc furnace in the presence of heavy metals (Kawecki, *Chem. Tr. J.*, 1946, **118**, 540).

Beryllium is steel grey in colour and is as hard as quartz. Its sp. gr. (1·83) is slightly more than that of magnesium (sp. gr., 1·74) which it resembles in some of its properties. The metal as such finds very few uses. It is employed for the electrodes of neon signs, windows of X-ray tubes and in cyclotrons. But the largest outlet for beryllium is in the preparation of its alloys with copper. These

usually contain 2-3% of beryllium. The alloys can be hardened by heat treatment and the tensile properties produced cover a wide range. The addition of small quantities of a third element such as iron, cobalt, nickel or chromium has the effect of permitting heat-hardening when beryllium content is much lower. Beryllium-copper alloy is non-magnetic and non-sparking. It is used in safety tools, flat and coil springs, pistons for vibrators, firing pins of revolvers and rifles, worm gear of sewing machines and in heavy duty bearings. The alloy has also been used for setting diamond in drill bits. Alloys of beryllium with nickel, iron and aluminium are also known.

Beryllium oxide is a highly refractory material melting at about 2750°. Crucibles made out of the pure oxide can be used at as high a temperature as 2300°. without being reduced by carbon. Sintered beryllium oxide is very hard and is useful as an abrasive for the grinding and polishing of hard alloys. Both beryl and beryllium oxide have been tried in ceramics. The partial substitution of felspar by beryl in porcelain compositions produces an excellent electrical porcelain with low coefficient of expansion and high insulating properties. A small addition of beryllium oxide to glass is said to make it harder. Beryllium salts have been substituted for those of cobalt for increasing the brilliancy of lithophone, and beryllium nitrate in small quantities has been used to strengthen the ash skeleton of mantles.

PRODUCTION

The annual world production of beryl is estimated at about 1,000 tons. India, Argentina, Brazil, and the U. S. A. are the chief producing countries. According to the U. S. Bureau of Mines, American industry consumes about 500 tons of beryl per year. Two-thirds of the total consumption goes into alloys, mainly Be-Cu alloys, and the remainder into the manufacture of ceramic glazes, super-refractories and abrasives.

In India, beryl is mined chiefly in Ajmer-Merwara, but the easily-won surface material is growing scarcer. The mica mining areas of Bihar and Madras are potential sources of 5-10 tons of by-product beryl per annum. Bhola (*loc. cit.*) estimated that in 1935 the cost of delivery per ton of beryl produced in Ajmer-Merwara, at the rail-head in Rajputana, varied from Rs. 35-60. Before the last War (1939-45) most of the beryl mined in India used to be exported to Germany and the United States.

ANNUAL PRODUCTION OF BERYL IN INDIA

	Qty. (Tons)
'32	281
'33	324
'34-'38 (Av.)	67·2
'39-'43 (Av.)	405
'44	500
'45	96

BETA Linn. CHENOPODIACEAE

A genus of 6 species of biennial, succulent herbs with swollen roots containing sugar, found mainly in western Europe and the Mediterranean region. Cultivated beets are the several forms of *B. vulgaris*, which is regarded as derived from the wild sea-beet, *B. maritima* Linn., a native of the coastal parts of the Mediterranean region and adjacent Europe.

The sugar-beet is extensively cultivated in temperate regions for the manufacture of sugar. The garden beet is a well-known vegetable. Swiss chard, *B. vulgaris* var. *cicla* Linn., a foliage beet, is one of the best pot-herbs, cultivated in summer in Europe and N. America. In northern India, *B. vulgaris* var. *benghalensis* is grown as pot-herb. The mangels, *B. vulgaris* var. *crassa* are derived from chard and are used as cattle food.

B. vulgaris Linn. THE BEET ROOT OR THE GARDEN BEET

D. E. P., I, 448 ; Fl. Br. Ind., V, 5.

ARAB.—*Salaq* ; PERS. & HIND.—*Chukandar*.

A biennial herb, producing in the first year, a large swollen fleshy root and a rosette of leaves, and in the second year flowers and seed. Under certain conditions, however, the plants may flower and set seed in the very first year. The root is usually of deep red colour, occasionally pink or white.

The garden beet has been known for a long time but its use as a vegetable is recent. It is probably a native of Europe, but its cultivation has now

spread to most parts of the world. It is grown in northern India in winter, and in Bombay and parts of south India throughout the year.

There are several varieties of beet, which differ only in form, colour and time of maturing. A good beet on cutting should show mostly the red succulent portion, and very little of the white woody rings. The variety most commonly grown in India is the Crimson Globe. Sutton's Blood Red, a long beet, is another good strain.

The garden beet can be grown on nearly all types of soils, but it does best on a fairly deep, moist, but well-drained, friable loam. It needs heavy manuring (potash fertilizers or well-decomposed cattle manure) and is sensitive to soil acidity. An application of common salt at the rate of 1 oz. per sq. yard, a fortnight before sowing, is said to be beneficial.

The seeds are thinly sown in well-prepared soil. They germinate in 10 days. The seedlings are thinned and spaced 6″apart. The crop is harvested in about three months (Macmillan, 306).

The beets are eaten boiled or as salad. They are also pickled. The tender leaves and young beets, the so-called beet greens, are used as pot-herb. Their use in this country is still largely confined to Europeans.

The beet root contains : moisture, 83·8 ; protein, 1·7 ; carbohydrate, 13·6 ; fat, 0·1 ; mineral matter, 0·8 ; Ca, 0·2 ; P, 0·06% ; Fe, 1·0 mg. ; vitamin B_1, 70 I. U. ; vitamin C, 88 mg./100 g. (*Hlth. Bull.*, No. 23, 1941, 31). The beet greens contain more iron and are richer in vitamins, particularly vitamin A (Fe, 3·1 mg. ; vitamin A, 21,000 I. U. ; vitamin B_1, 110 μg. ; and vitamin C, 50 mg./100g., Heinz Co. Nutrit. Chart, 1942, 21).

B. vulgaris Linn. var. rapa Dum. THE SUGAR BEET

The sugar beet is a white-rooted biennial, which has been developed by continuous selection from the mangels. It is much smaller in size, but the sugar content of roots is higher, being foquently over 20% by weight.

Although it has been known for a long time, it became an important crop only in the nineteenth century. During Napoleonic wars, France was cut off from the supply of sugar and Napoleon encouraged the cultivation of sugar beet for its manufacture. As a result of continuous selection the sugar content of roots was raised from 5 to over 20%. The sugar beet is now extensively cultivated in Europe, and to a considerable extent, in the U. S. A. and New Zealand. It has been experimentally tried in several parts of India, and promising results have been obtained in the North West Frontier Province both with regard to the yield of roots per acre and the sugar content (Indian Sugar Comm. Rep., 1921, 199; *Annu. Rep., Dep. Agric. N.W.F.P.*, for 1937-38, i, 12 and ii, 1).

The sugar beet requires a mean temperature of 75°F. for germination. In its early stages, it must have a cool climate (32–50°F.). The root begins to develop in spring, when the temperature ranges from 68–86°F. For sugar accumulation, a temperature higher than 86°F is required. Such variations in climatic conditions are met with in the Peshawar valley, from early October to the end of April. Sugar beet has been successfully cultivated there, and the average yield of roots per acre from 1935–41 was 9·6–17·7 tons and the sugar percentage, 12·9–14·3 (Shah, *Indian Fmg.*, 1945, **6**, 57).

The roots, cultivated in England, contain : moisture, 76·6 ; protein, 1·1 ; oil, 0·1 ; soluble carbohydrates, 20·4 ; fibre, 1·1 ; ash, 0·7% (*Bull. Minist. Agric. Lond.* No. 124, 1945, 3). The ash content of roots (moisture-free) is 3–5% of which K_2O is 40–60, and P_2O_5, 10–20% (Wehmer, I, 291).

For the manufacture of sugar, the roots are cut into thin slices and sugar is extracted by diffusion in a series of tanks containing hot water. The efficiency of the process is 97%. The subsequent treatment of the extract for the production of crystalline sugar is the same as in the case of sugarcane juice.

The by-products of beet sugar industry are the tops, the pulp or slices, the filter-cake and molasses. The tops and pulp are used as stock food, and the pulp and filter-cake as manure. Recently the dry pulp has been found to contain about 30% of galacturonic acid in the form of pectic substances. This acid forms the base for the synthesis of vitamin C. A ton of dry beet pulp is reported to yield 50 lb. of the vitamin C (*Chem. Age, Lond.*, 1946, **51**, 35).

Beet molasses contains : water, 20 ; sucrose, 50 ; organic non-sugars, 20 ; and ash, 10% (Riegel, 239). Unlike cane molasses it does not contain any invert sugar. Its protein content works out to about 3·7%. It contains up to 3% of betaine (Wehmer, *loc. cit.*, 290), which is recovered from it. Beet

molasses serves as stock feed, and is also used for sweetening other animal feeds. It is used as raw material for the manufacture of alcohol.

About one-third of the total world production of sugar is from beet. In 1939, beet sugar production was 12·5 million short tons, while the total quantity of sugar produced amounted to 35·5 million short tons. Russia (2·9), Germany (2·1), the U.S.A. (1·8), and France (1·1 million short tons) were the principal producers of beet sugar.

Beet sugar used to form about 10% of the total imports of sugar into India. In 1926-27, 1·8 million tons valued at Rs. 3·9 crores were imported. The imports declined after the grant of protection to the Indian Sugar Industry in 1931, and have stopped completely since 1940.

IMPORTS OF BEET SUGAR

	Qty. (1,000 tons)	Val. (Lakhs of Rs.)
'34-35	26·8	24·0
'35-36	23·6	20·6
'36-37	2·0	2·0
'37-38	0·7	0·8
'38-39	4·5	5·5
'39-40	5·6	7·5

Betel leaves, see **Piper betle**

Betel nut, see **Areca catechu**

BETULA Linn. BETULACEAE

A genus of trees and shrubs, comprising some 38 spp., widely distributed from the Arctic Circle to southern Europe, the Himalayas, China and Japan, and extending to the southern United States. Some of the species are valuable timber trees of which *B. pendula* Roth and *B. pubescens* Ehrh. are the common European species. *B. lutea* Michx. the Yellow Birch, and *B. papyrifera* Marsh. the Paper Birch, are American timber trees. The bark of *Betula lenta* Linn., a North American species, is a source of commercial wintergreen oil. Three species occur in India.

B. alnoides Buch.-Ham. Syn. *B. acuminata* Wall.
INDIAN BIRCH

D. E. P., I, 451; C. P., 131; Fl. Br. Ind., V, 599.

HIND.—*Bhujpattra*; BENG.—*Hlosunle*; NEPAL—*Saur, sons*; ASSAM—*Dingleen*.

A moderate-sized to large tree, with a straight stem, up to 100′ in height and 4–5′ in girth, found in the Himalayas from the Ravi eastwards (5,000–10,000′), the Khasi Hills (3,000–5,000′), Manipur, and the hills of Burma (5,000–6,000′).

The wood is white or grey, moderately hard, straight-grained and even-textured. It is generally differentiated into distinct whitish sapwood and light greyish-red to pinkish-grey heartwood, which turns to light greyish-brown or grey. It is moderately heavy (sp. gr., 0·50–0·65; air-dry wt., per c. ft., 32 lb. for the U.P. specimen, and 41 lb. for the Bengal specimen), and is a strong and fairly durable timber. It is liable to get stained if left exposed too long after felling. It is very easy to saw, work, peel, turn and finish.

Anatomically the wood is featured by distinct but relatively inconspicuous growth rings, abundant diffused meta-tracheal parenchyma and terminal parenchyma, medium coarse non-septate fibres with minute bordered pits, and narrow, homogeneous or nearly homogeneous rays which are somewhat darker than the background and form a low, inconspicuous fleck on the radial surface (Pearson and Brown, II, 964).

It is one of the few Indian woods which can be favourably compared with European timbers for plywood. In the tests held at Dehra Dun, it surpassed the specifications for imported plywood and was found to be exceptionally good when tested in the form of plywood teaboxes. However, on account of its high cost of extraction and unsteady supplies, it does not appear to be very economical for general plywood manufacture (Kapur, *Indian For. Rec., New Series, Util.*, 1942, **2**, 272). According to Limaye & Mohammad (*ib.*, 187), it is good in drying and holding glue, and is one of the best Indian woods for aircraft plywood. It is suitable for interior of cabinet work, turnery, spools, pill boxes, etc., and is excellent for tool handles of screw drivers, planes, saws, etc. In Calcutta, it is used in gramophone and radio cabinet work. Tight clean veneer can also be obtained from it.

The main source of supply is the northern circle of Bengal, where 50,000 c. ft. are said to be available annually. Simla and Bushahr divisions of the Punjab, and the Jaunsar and Tehri forests of the United Provinces, can supply small quantities. The price quoted in Bengal in 1937 was Rs. 50–80 per ton in sawn sizes (Trotter, 1944, 55).

B. cylindrostachys Gamble

D. E. P., I, 453 ; Fl. Assam, IV, 328.

BENG.—*Saur* ; LEPCHA—*Sunli* ; NEPAL—*Sauer*.

A lofty tree reaching a height of 120′, found in the Darjeeling hills, from the terai up to 6,000′, and in Assam up to 4,600′.

The air-dry leaves have been found to contain 0·12, and the bark, 0·04% of a viscous essential oil.

The wood is light reddish-brown (sp. gr., 0·59 ; air-dry wt., 38 lb. per c. ft.), straight-grained and even-textured. It is very similar to that of *B. alnoides*, but somewhat darker in colour and generally harder and heavier. It is strong and seasons well. It is little used except for firewood and charcoal (Pearson and Brown, II, 966). The fruit is edible.

B. utilis D. Don Syn. *B. bhojpattra* Wall.
HIMALAYAN SILVER BIRCH

D. E. P., I, 452 ; C. P., 131 ; Fl. Br. Ind., V, 599 ; Brandis, Fig. 191.

HIND.—*Bhujpattra*.

A moderate sized tree up to 65′ high, sometimes a mere shrub, forming the upper limit of forest vegetation. It is met with throughout the main Himalayan range from Bhutan westwards, ascending 14,000′. It extends to western Tibet and China.

The bark is shining, reddish-white or white. The outer bark, consisting of thin papery layers peeling off in broad horizontal rolls, was once used as writing material. It is valued for packing, and for covering umbrellas, roofing, etc. and hookah tubes (Troup, III, 909 ; Gamble, 668).

The wood is white with a pinkish tinge, tough, even grained and moderately hard. It is elastic, seasons well, and does not warp. Its average wt. is 44 lb. per c. ft. It is extensively used for building in the inner arid Himalayas (Gamble, *loc. cit.*).

The twigs are used for rope bridges, and the leaves are used as fodder.

BIDENS Linn. COMPOSITAE

Fl. Br. Ind., III, 309.

A genus of annual or perennial woody herbs comprising 150 cosmopolitan species, chiefly of American origin. 3 species have been reported in India. *B. pilosa* Linn. is an aromatic shrub. It is medicinal in Malaya, Java, and Indo-China. An infusion of the plant is said to be taken in Malaya for coughs. The plant is reported to be eaten readily by cattle (Burkill, I, 324).

BILE

Bile is the secretion of liver, stored up in gall-bladder and poured into the duodenum for digestive purposes. In man and some of the carnivorous animals, it is yellow or brown, but green in herbivorous animals. Ox bile is a viscid, neutral or faintly alkaline fluid (pH, 7·15; sp. gr., 1·014–1·018). It has a characteristic musky odour and disagreeable bitter taste.

Bile salts, bile pigments, mucin and lipoids form the principal constituents of bile. Human bile has the following composition : bile salts, 9·14 ; bile pigments and mucin, 2·98 ; cholesterol, lecithin and fat, 1·18 ; ash, 0·78 ; water, 85·92% (Thorpe, I, 689).

The bile salts, sodium glycocholate ($C_{26}H_{42}NO_6Na$) and sodium taurocholate ($C_{26}H_{44}O_7NSNa$), are derived from the bile acids, glycocholic acid ($C_{26}H_{43}O_6N$) and taurocholic acid ($C_{26}H_{45}O_7NS$), respectively. These acids are formed in the liver by the union of cholic acid, $C_{24}H_{40}O_5$ a complex ring compound, closely related to ergosterol and cholesterol, with the amino acids glycine and taurine.

Bile owes its colour to biliary pigments derived from haemoglobin, the coloring matter of blood, its colour being determined by the relative quantities of the two chief pigments, bilirubin, $C_{33}H_{36}N_4O_6$, an orange-red pigment, and biliverdin, $C_{33}H_{36}N_4O_8$, a green pigment. Among the inorganic salts, sodium chloride, and the phosphates of calcium, iron and magnesium, are important.

The physiological importance of bile lies in its neutralising the acid of chyle. Bile salts have the property of lowering the surface tension of the fluid contents of the intestine, and facilitating the action of the enzymes of pancreatic juice. They are also solvents of fatty acids, and in their presence, unhydrolysed fats and unsaponifiable lipoids may be absorbed from the intestine. Bile salts stimulate secretion of bile and increase peristalsis.

Purified ox bile (*Extractum fellis bovini*) is prepared by evaporating 20 parts of fresh ox bile to 5 parts, then mixing it with 10 parts of 90% alcohol, separating the precipitate and evaporating

the clear fluid to the consistency of a thick syrup (Martindale, I, 516). It is a dark yellowish-green bitter-sweet mass, and is dispensed in pills, tablets and capsules. It is used in the treatment of anaemia, gall stones, constipation, jaundice and other disorders of the liver. It has also a mild laxative action and may be used in the form of an enema. Bile may be used to aid the absorption of fats as in cases of biliary fistula.

Bile is not palatable and is also unstable. Consequently its salts and preparations are used in medicine. The chief of these is sodium tauroglycocholate, a mixture of the two bile salts, which is administered in cases of supposed deficiency of biliary secretion to assist emulsification of fats, and as a purgative. As a chologogue, it is beneficial in some forms of intestinal dyspepsia. It is prepared by extracting dried ox or pig bile with dry alcohol, decolourising with charcoal, and precipitating with ether. It occurs as a yellowish-brown hygroscopic powder having a sweet, but afterwards bitter taste, and an odour resembling that of bile. It may also be prepared from the bile of buffaloes (Lall, *J. sci. industr. Res.*, 1945–46, **4**, 178).

Bile is also used in cleansing woollen goods especially carpets, and by artists to ensure the uniform spreading of water-colour on paper (Thorpe, *loc. cit.*).

Bilimbi, see **Averrhoa bilimbi**

BIOPHYTUM DC. OXALIDACEAE

Fl. Br. Ind., I, 436.

A genus of 60 species of herbs, with sensitive leaves, occurring in warmer countries. 8 species are found in India.

B. adiantoides Wight, *B. reinwardtii* Walp., and *B. sensitivum* DC. are medicinal (Burkill, I, 325; *vide* also Dymock, Warden & Hooper, I, 247).

B. sensitivum is reported to be used for chest complaints, and its ash for stomach-ache.

Birch, Himalayan Silver—, see **Betula utilis**

„ Indian —, see **Betula alnoides**

BIRDS

(C. P., 131; Pls. XXVIII & XXIX; *vide* also Fletcher & Inglis; and Sálim Ali).

India, with her diverse physical features and climates, is the home of a large variety of birds (about 2,000 indigenous and 350 migratory species). Several of these are of direct benefit to man. Poultry farming is as ancient as agriculture, and several species of wild birds are hunted to supplement our food supplies.

The feathers of many species possess high ornamental value because of their variegated forms and colours. The principal plumage birds of India are: the Adjutant and other Storks (*Ciconiidae*); Herons and Egrets (*Ardeidae*); Floricans and Bustards (*Otididae*); the Darter (*Anhinginae*); Hoopoes (*Upupidae*); Junglefowl, Peafowl, and Pheasants (*Phasianidae*); the Rollers (*Coraciidae*). Early efforts at ostrich farming in India, near Agra, did not meet with any success (C. P.), and the farming of Egrets for feathers, once extensively practised in Sind, has now practically disappeared (Sálim Ali, *Curr. Sci.*, 1936, **4**, 470). The skins of a few large birds (Ostriches) are used for making fancy leathers, and in India there was formerly a small trade in the skins of some wild birds (Kingfishers – *Alcedinidae*. Junglefowl, the Monal, Tragopan Pheasants, and Paroquets. C.P.). But, the ban on the export of feathers of wild birds, while affording safety to several ornamental birds, has led to the extinction of trade in their feathers, as well as in bird-skins.

At present the only feathers that are still extensively used for decorative purposes in India are peacock-feathers. Fans, picture-frames, etc., are made from them in Agra, Benares, Jhansi, etc. There is a limited demand for peacock feathers from America for theatrical purposes. In India, the use of feathers and down collected from domesticated species, in upholstery and for the making of beds is not prevalent to any considerable extent. The quill-feathers of domestic fowls and pigeons are mostly used for tooth picks; and the wing quills of geese, for writing-pens.

Several species of birds are kept as pets or as cage birds, because of their powers of singing and mimicry. Some are trained for use in falconry and hawking. The ancient practice of using pigeons as carriers of messages proved helpful during the recent Wars.

Birds play a prominent role in the economy of nature. Several species are closely associated with

agriculture, horticulture, and silviculture. The Black Drongo (*Dicruridae*), the Roller or Blue Jay, the Bee-eaters (*Meropidae*), the Hoopoe, and the Swallows (*Hirundinidae*) are invariably present in the neighbourhood of cultivation. They act as natural check on the increase of insect pests of crops and agricultural produce. Woodpeckers (*Picidae*) destroy vast quantities of grubs of wood-boring beetles in timber trees. Field rats and mice are controlled by some members of the family *Falconidae*, and the larger owls (*Tytonidae* and *Asionidae*). Vultures (*Aegypiidae*), Kites (*Falconidae*), and Crows (*Corvidae*) are invaluable as scavengers. They speedily dispose of carcasses and garbage. The birds that visit flowers regularly to feed on nectar and are instrumental in cross-fortilizing them are: Bulbuls (*Pycnonotidae*); Babblers, Chloropsis, Iora, etc. (*Timaliidae*); Crows; Drongos; Finches (*Fringillidae*); Flowerpeckers (*Dicaeidae*); Flycatchers (*Muscicapidae*); Blackbirds, Magpie-Robin (*Turdidae*); Mynas and Starlings (*Sturnidae*); Orioles (*Oriolidae*); Shrikes (*Laniidae*); Sunbirds (*Nectariniidae*); Warblers (*Sylviidae*); Weavers (*Ploceidae*); and White-eyes (*Zosteropidae*). Certain birds like Chloropsis, Sunbirds, White-eyes and Flowerpeckers possess special adaptations in their bill and tongue for nectar eating. These Indian flowerbirds are amongst the most important avian pollinators.

Among the frugivorous birds responsible for seed dispersal may be mentioned: Bulbuls, Thrushes, Babblers, Starlings and Mynas, Barbets (*Capitonidae*), Hornbills (*Bucerotidae*), and Fruit Pigeons (*Treroninae*).

The excrement of birds when found in quantity has high manurial value. Guano, occurring on the coasts of certain islands off the coast of Peru consists of the excrement of sea-birds, and is used as a phosphatic manure. Nothing similar to it has yet been found in India.

The activities of some birds are harmful. Graminivorous birds often cause serious damage to newly sown or ripening food crops. Some of these like the Pheasants, Junglefowl, Partridges, Quails, Pigeons and Doves, and Geese, and Cranes, damage newly-sown grain. Geese and Cranes also pull up the tender shoots of newly-sown gram (*Cicer arietinum*). Birds mainly responsible for damage to standing crop are Buntings and Finches. Bayas or Weavers birds (*Ploceidae*) raid ripening paddy crops. Other major crop-damaging birds are Mynas and Starlings, particularly the Rose-coloured Starling, and all Paroquets. While the Rosy Pastor destroys locusts, it is harmful to the *jowar* (*Sorghum vulgare*) crop. Regular despoilers of orchards and vegetable gardens are Paroquets, Bulbuls, Barbets, and Mynas, while a great many others such as Crows, White-eyes and even Woodpeckers occasionally do minor damage.

The larger birds of prey, like the Hawk-Eagles of the genera *Spizaëtus* and *Hieraëtus* are destructive to game birds, and instances are known of their having attacked pilots of aeroplanes. The Pariah Kite (*Milvus govinda*) and the Shikra Hawk (*Astur badius*) are notorious 'chicken snatchers'. Herons, Storks, Cormorants (*Ciconiidae* and *Phalacrocoracidae*), Pelicans (*Pelecanidae*), etc., destroy large quantities of fish including species that are of value as food fishes. The Bee-eaters prey largely upon honey-bees.

EDIBLE AND GAME BIRDS

Strictly speaking all birds are edible, since there are none with poisonous flesh. But birds which feed on carrion are not eaten. Here, only wild birds which are normally used for food in India are included since domesticated birds are dealt with under a separate heading (*vide* Poultry).

True game birds are recognised as belonging to the order *Gallinae*, but the term 'game birds' includes many others such as pigeons, sandgrouse, hemipodes and also some water-birds. All of them conform to the sportsman's standard, that 'they are good to eat and difficult to shoot'.

1. Bustards (*Otididae*).

The Bustards are closely allied to the Plovers. Their favourite food appears to be grasshoppers, locusts, etc., and other insects, besides grains and young shoots of plants. They are first rate sporting birds and are excellent eating. Six species are recognised, of which the largest are the Great Indian Bustard and the Eastern Great Bustard. The latter is a rare vagrant to India and Burma, but the former is found over a large part of peninsular India.

2. Cranes (*Gruidae*).

The Common Crane (*Grus grus*) and the Demoiselle Crane (*Anthropoides virgo*), locally known

[illegible]
[illegible]Y QUAIL
[illegible]
[illegible]
[illegible] JUNGLE FOWL
[illegible]OOD PHEASANT

1. ROSY PASTOR
2. SHAMA
3. BLACK DRONGO
4. INDIAN ROLLER
5. SHAHIN FALCON
6. EDIBLE NEST SWIFTLET AND NESTS

as *Kulang* or *Koonj*, visit India in enormous numbers during the cold weather, Oct.-Mar. They are mainly vegetarian, living on tender shoots of grasses and crops, digging up newly-sown rice, wheat or gram. They are considered very good eating.

3. Ducks & Teals, Geese and Swans (*Anatidae*).

The Ducks and Teals, Geese and Swans belong to the natural order, *Anseres*. The great majority of our *Anseres* (wildfowls) are migratory. They visit India in winter, arriving about October or November and departing again in March for their breeding grounds. These lie chiefly in the country north of the Himalayas,—European Russia, Siberia and Central Asia. These birds live mostly in fresh-water (rivers and *jheels*), but to a lesser extent in brackish water (estuaries and backwaters by the sea). Their food consists of vegetable as well as animal matter. The geese, however, live predominantly on vegetable matter: grass shoots, young crops as well as grain. The flavour of their flesh varies considerably with their food. Some species considered good for the table at certain seasons are rank, fishy and uneatable at others.

Ducks and Teals: Thirty-five species and subspecies of wild duck (including teal) are recorded in India. Twenty-six of these are winter visitors from extra-limital northern countries, and nine are resident species. Many of these, however, are rare.

The species most commonly and abundantly netted for food are: Common Teal, Garganey or Blue-winged Teal, White-eyed and Common Pochards, Pintail, Gadwall, Wigeon and Shoveller, which are some of the most gregarious species that can be netted wholesale. The Mallard, Spotbill, Nukta, Whistling and Cotton Teals, etc. are also occasionally brought in. This group, on account of its varied nature constitutes the sportsman's ideal.

These birds are conveyed alive in baskets or coops. For distant markets, the practice is to kill, pluck and paunch them, and to transport them in ice. About five to ten thousand wild ducks and teals are offered for sale in Calcutta during the season (Nov.-Mar.). These birds mostly come from the 24-Parganas, Rajshahi, Khulna, Nadia and Murshidabad dists. of Bengal, also from the Monghyr dist. of Bihar, and the Lucknow dist., U. P. Wild geese come mostly from Lucknow. Wild duck and teal sold in Bombay markets come from Lucknow, and wild geese from Lucknow and Allahabad. 2,500-3,000 birds are offered for sale during the season (Jan.-Mar.).

About 3,000 wild duck and geese are sold annually in the Lucknow market. They come mostly from the tahsils of Daryabad and Rudauli in the Bara Banki dist. There was an extensive wildfowl netting industry in Sind before the Sukkur Barrage Scheme came into being, but no information is available regarding its present position.

Geese: Seven species, all migratory, are recorded within Indian limits. The only two, netted for sale in city markets are: (1) the Grey Lag Goose and (2) the Bar-headed Goose.

The Grey Lag is the ancestor of all our domestic breeds of geese. In size, colour and general effect, it is very similar to the normal brown phase of the domestic goose, with a grey rump and white-tipped pink bill. It keeps mostly to the larger *jheels* in northern and north-western India and Sind, and is destructive to young wheat, rice crops and gram fields.

The Bar-head is generally grey and brownish, with a white head and sides of neck, and two distinctive broad black bars on the nape. In winter, it is fairly common throughout northern India and Assam, and in small numbers straggles as far south as Mysore. It keeps to rivers and *jheels* and does damage to young winter crops.

Swans: These are large birds, pure white in colour, and are rarely met with inside India (mostly in the N. W. F. P., Punjab and Sind, during the cold weather). They fly with outstretched necks unlike the pelican (Hind. -*Hawasil*), which flies with its neck pulled in.

4. Doves and Pigeons (*Columbidae*).

Several varieties of Doves and Pigeons are found throughout India. Pigeons are arboreal, and Doves are also adapted for walking. They subsist entirely on fruits and berries.

Among this group, the Blue Rock-Pigeon which is widely distributed is often killed for eating. The Eastern Stock-Pigeon is a migrant to north-western India in winter. Occasionally large flocks are met with, furnishing good sport. The Snow Pigeon, a Himalayan bird, is sometimes brought down in some numbers to Calcutta by hill people and sold as cage birds. The Spotted Dove, the

Ring Dove and the Red Turtle Dove are generally found in rural and urban areas. The Bar-tailed Cuckoo Dove is a bird of the Himalayan hill forests.

Green Pigeons (HIND.—*Harial*) include numerous species, green or yellowish-green in colour. This gives them perfect protection among the foliage of trees where they live. They are much sought after by sportsmen, and also snared or limed and brought to bird markets, though never in considerable numbers.

The Imperial Pigeons are of particular interest to sportsmen, on account of their size. They are found abundantly in the forests of the foot hills and the plains. These birds are generally coveted as show-birds.

5. JUNGLEFOWLS, PARTRIDGES, PEAFOWLS, PHEASANTS, & QUAILS (*Phasianidae*).

Junglefowls, Partridges, Pheasants and Quails, all belong to the Gallinaceous bird family *Phasianidae*. They are largely vegetarian in their diet though most eat insects and other animal food as well. They are highly esteemed as food, and consequently enjoy a ready demand everywhere. They are extensively shot for sport.

Junglefowl: Two species occur in India: the Red and the Grey. The former is the ancestor of all domestic breeds and is found in the Himalayan foothills, and south through the eastern Central Provinces to the Godavari river; and the latter, in peninsular India, west and south of the above. They are snared and brought to nearby markets, but not on any extensive scale.

The Red, and Painted Spurfowl somewhat smaller than the Junglefowl, are also snared and sold.

One species of Megapode (*Megapodidae*) is found in the Nicobars. In general habit, it resembles the Junglefowl; but builds mounds of decaying leaves for laying its eggs in. It is found in pairs or flocks. It feeds on land-shells, small animal life and vegetable food. Its flesh is delicious, comparable to that of a fat Turkey.

Partridges: The majority of edible wild birds sold in Indian markets are the partridges and quails. Of the former, by far the largest numbers belong to the Grey species (*Safed Teetar*). It is a popular cage bird, prized for its fighting qualities and affords good sport. Then come the Black Partridge (*Kala Teetar*) of northern India, and the closely related Painted Partridge of the peninsular area which also afford good sport. So extensive is the netting of Grey Partridges that despite the statutory close seasons, which are intended to give the birds respite during the breeding season, whole districts have literally been swept clean of the birds. Black and Painted Partridges have also dwindled considerably in recent years, which indicates how much they are relished as food. Grey and Black Partridges are imported into Calcutta from north India, the chief centres of export being Delhi and Lucknow. Lucknow itself apparently gets supply of Grey Partridges largely from Jhansi in central India. Grey Partridges come to the Bombay market mostly from the Deccan plains around Poona and Nasik, and Painted Partridges from around Janjira on the West Coast. The Red-legged Partridge or *Chukor*, which lives high up in the Himalayas, provides good shooting. It is also snared and sent down in small numbers to the markets, especially of northern India.

The Swamp-Partridge or Kyah is considered a delicacy. It is a bird of swamps, as in the Himalayan terai and around *jheels* in Assam. This bird is trapped and trained for fighting and betting purposes.

Peafowl: There are two distinct species: the Common Peafowl, distributed over practically the whole of India, except in the extreme north-west, and Ceylon; and the Burmese Peafowl, found from Burma through Malaya States to Java. The Common Peafowls are held sacred in many parts of the country, where they become tame and semi-domesticated. If persecuted, they soon become wild and shy. They keep down snakes and other poisonous reptiles. When young, they are good for eating.

The Peacock does not reach maturity until about 3 years old when it acquires its gorgeous plumage. The males moult their long trains after the breeding season, about September, and the feathers are collected for sale. In some parts of the country large numbers are also killed and their complete tails sold.

Pheasants: The true pheasants constitute a goodly proportion of this family. They are large birds with marked sexual dimorphism; the cocks in most cases are adorned with extravagantly

gorgeous plumage and showy appendages. The majority, however, live in secluded damp jungles or at high altitudes in the Himalayas, far from the normal habitations of man. The *pahari* folk snare them in a number of ingenious ways. They are eaten and their skins bartered or sold, and a few live birds brought down to the plains for sale.

The two pheasants *par excellence* for sportsmen in the Himalayas are the *Cheer* and the Horned Pheasants, which are among the best of game birds for the table. The most prominent plumage pheasants are the Monal, the Amherst Pheasant, the Trapogans and the Blood Pheasants, found at high altitudes. They are purchased by fanciers more for aviaries than for the edible qualities of their flesh. The high prices paid for the ornamental feathers of these birds in Europe have been the cause of serious depletion in their numbers, in many areas of their homeland, which extends all along the Himalayas into eastern China and north-eastern Asia.

The Peacock Pheasant is found from Sikkim, Bhutan eastwards along the Himalayas to Assam and Manipur, and through Burma to Siam. Its ornamental plumage and displaying habit make it an excellent aviary bird. It feeds on insects, worms, grains and seeds. Its flesh, though rather dry, is well-flavoured.

Certain species of pheasants that live in the Himalayan foothills may, however, be regularly seen in various urban bird markets, though never in any considerable numbers. The majority of these also are kept as pets though some are purchased to be eaten. The species most commonly offered for sale is the Kalij, known in the U. P. as *Kala Murgha*. Among the other Himalayan pheasants occasionally seen in bird markets of larger towns, like Bombay and Calcutta, are the *Koklass* (*Pucrasia macrolopha*) and the Monal (*Lophophorus impejanus*). The supply centres of pheasants for the Bombay market are Nepal and Lucknow. In Lucknow itself the birds evidently come from such localities as Almora and Naini Tal.

Quails: The one edible bird that every epicure is constantly on the look-out for is the Quail. Few people buying quails for eating discriminate between the three or four species that are commonly sold in markets, except that they are careful to select the larger Grey Quail (*Coturni*), rather than the Rain Quail or the Bush-Quail.

The Grey Quail (HIND.—*Ghagas Bater*) is a winter visitor found in particularly large numbers in northern and north-western India, between October and April. A small number are also resident and breed in this country. The birds pass through Kashmir, Punjab and the north-west on spring and autumn migration every year (Mar.-Apr. and Oct. Nov.) in enormous numbers and are extensively netted all along their route. On the outward migration in spring they are very fat and juicy and considered a great delicacy. In north-western India it is a common practice to buy large numbers in season and to keep them in darkened underground pits where they are well-fed and fattened for the table. The Grey Quail provides good sport and is sought after as a cage bird for fighting and for betting purposes. During the season (Oct.–Mar.), approximately 100,000 quails—mostly Grey Quails—are sold in the Lucknow municipal markets.

The Rain Quail or *Chinak Bater*, somewhat smaller in size is a purely Indian species, but moves about to some extent locally according to natural conditions of rainfall, etc. It is found practically throughout south-east India, from Madras to the extreme south. The Bush-Quail or *Lowwa* is a resident and completely sedentary form. It lives in coveys in dry scrub country unlike the Grey and the Rain Quails which live among standing crops or grass. These birds are netted on a large scale and may usually be had in most bird markets.

The Hemipodes (*Turnicidae*) resemble small-sized quails, but are distinguished by the absence of the hind toe whence they get their name of Bustard-Quail. They are sometimes netted and brought to the market for sale as edible birds and cage birds.

6. PLOVERS, SANDPIPERS, SNIPES and WOODCOCKS (*Charadriidae* and *Scolopacidae*).

These birds are adapted to life in open country, generally near water. They are sometimes shot for the table, the last two very extensively.

The Plovers are found throughout India. The familiar forms are the Lapwings, the Golden Plover, and the Ringed Plover. This group includes the Turnstone, the Oyster-catcher, and also the Stilt, the Avocet, and the Ibis-bill.

The Sandpipers are natives of Europe and north Asia. They arrive in India as early as August and

stay till May. In winter, they are found throughout India, Burma, and Ceylon.

The Snipe and Woodcock belonging to the Sandpiper family are perhaps the best known of all game birds. They are brown and fulvous birds of a highly camouflaging colour pattern, and are characterized by long, straight slender bills for probing in wet mud. In India, the Woodcock is a winter migrant to the Nilgiris and adjacent hills in small numbers, the majority being resident in the Himalayas and merely moving down to lower levels in winter. Snipes of several species, but mostly Fantail and Pintail winter in India in enormous numbers between September–April.

7. SANDGROUSE (*Pteroclidae*).

Sandgrouse come halfway between pigeons and true game birds. They are more or less desert-haunting birds, and most of them are winter immigrants. They live entirely on the ground, flying immense distances for water daily with almost clock-work regularity. They are found in flocks which when lying or squatting and feeding in fallow fields are undetected even at close range on account of their protective coloration, but are most often noticed in flight. Excellent sport can be had as the birds fly at their appointed time (a couple of hours after sunrise and again a little before dusk), to and from their drinking ground. It requires a good shot and a heavy charge of lead to bring them down, for they are fast fliers and their plumage is very firm and close. They are often caged.

The only other wild birds that are commonly eaten in India on a sufficiently large scale are the Rosy Pastor, '*Jowari* Bird', and the Short-toed Larks, wrongly called 'Ortolan'.

The Rosy Pastor breeds in eastern Europe, western and central Asia, and visits India between September and April in enormous swarms and often cause considerable damage to ripening *jawar* and other cereal crops. During the season, these birds are found in large numbers in the Punjab and the N. W. F. P. They also eat berries of all kinds and are particularly destructive to locusts, which they demolish on a gigantic scale. By the time the birds leave for their breeding grounds, they put on a large quantity of fat and are much sought after in that condition. They are mostly secured by shooting and their swarms are so dense that a single shot kills several birds.

The name Ortolan is wrongly applied in India to the 2 species of Short-toed Larks (*Alaudidae*, HIND.—*Bagheyri*) which visit northern India during winter months in great numbers. The birds keep in huge flocks, gleaning grass seeds in flat, open semi-desert country or in harvested fields. Very large numbers are netted and sold in the bazaars of north and north-western India. They are considered a great delicacy and are in special demand just before their spring emigration (March) when they are very fat. The real Ortolan of Europe is the Bunting (*Emberiza hortulana*).

CAGE BIRDS

Cage birds being popular are sold in almost every important city of India. The shopkeepers get them through their agents from bird-catchers, the *buhelias*.

Harper (*Avicult. Mag., New Series*, 1903, 1, No. 8) describes the various methods adopted in bird catching in India. Birds which generally feed on the ground like Larks, Starlings, Wagtails, Doves, etc., are caught by means of clap-nets. Large numbers of Quails, Cranes, Sandgrouse and Geese are netted and brought alive to the markets. The trap-cage is useful for catching flocks of small birds. Drongos, Rollers, Shamas, etc., are caught by using bird-lime, prepared by melting together the milk of the Peepul tree, mustard oil and vegetable resin. Many types of cages or baskets made of split bamboo are used for transporting birds.

The following is a list of the more important cage birds and tame birds of India:

1. Babblers: Chloropsis (HIND.—*Harewa*) and Laughing-Thrushes (*Timaliidae*).

2. Bulbuls: The Red-vented Bulbul is the most popular, and is prized for its fighting qualities.

3. Buntings, Finches and Sparrows (*Fringillidae*).

4. The Bustard-Quail.

5. Cuckoos (*Cuculidae*): the Koel, the Common Hawk-Cuckoo, the Indian Cuckoo, etc.

6. Doves and Pigeons.

7. Drongos: The large Racket-tailed Drongo is a good mimic and a great favourite.

1 BENINCASA HISPIDA

2. BERBERIS ARISTATA

3. BERBERIS ASIATICA

4. BERBERIS LYCIUM

8. The Falcons (*Falconidae*) are generally tamed and used in falconry and in bird hunting.

The Shahin Falcon, found generally along the lower hills of the Himalayas and in south Assam, is now the most commonly used falcon in hawking. It is noted for speed and accuracy in flight, and is trained for 'a standing quit'. It is not flown from the hand at the quarry, but is allowed to hover and circle high in the air and to stoop on the game when flushed. The Laggar Falcon is more docile, but is now seldom trained. The Indian Shikra is a plucky little hawk trained to hunt Koels and other small Game birds (Fn. Br. Ind., Birds, V, 150).

9. Flycatchers.

10. Flowerpeckers.

11. The Indian Grackle and sometimes the Southern Grackle (*Graculidae*), brought into the bazaar by scores at a time, are the best known, being fine talkers and mimics.

12. Jays and Magpies (*Corvidae*).

13. Larks (*Alaudidae*) are popular song birds.

14. Munias and Weaver birds (*Ploceidae*).

15. The Mynas, the Rosy Pastor, the Indian Starling and several other species of the family, *Sturnidae*, are common cage birds. Albino individuals are preferred.

16. The Orioles are found over the greater part of India, on large fruit trees. The Golden Oriole is known as the 'Mango Bird'.

17. The Parrots (*Psittacidae*): the Rose-ringed Paroquet found throughout India, the Large Indian Paroquet, the Blossom-headed Paroquet, the Slaty-headed Paroquet, and the Indian Loriquet.

18. Partridges, Peafowls, Pheasants and Quails.

19. The Pipits and Wagtails (*Motacillidae*) are brought for sale as edible birds. Only the Large Pied Wagtail is kept as a song bird.

20. The Pitta (*Pittidae*).

21. The Indian Roller, called *Nilkant* in Hind. occurs throughout the plains and is held sacred.

22. Sandgrouse.

23. The Shama is the most reputed of cage birds, being the finest of oriental songsters and a mimic as well. The Shama, the Robins and the Thrushes belong to the family *Turdidae*.

24. Tits (*Paridae*).

25. The Indian White-eye.

EDIBLE BIRDS' NESTS

The edible birds' nests of commerce are built by several species of Swifts of the genus *Collocalia* (*Micropodidae*). These birds are smaller in size than the House-Sparrow and live in rock caves in islands of granite or limestone formation. They are said to desert the nest islands at the end of their breeding season, *i.e.*, about May.

The genus *Collocalia* is distributed more or less over the entire Oriental and Australian Regions. 4 species occur in India, Burma and Ceylon. Of these, *C. fuciphaga* Thunberg (the Indian Edible-nest Swiftlet) is found in Ceylon, the West Coast, the Nilgiris, Anamalais and the Himalayas. The other three species *C. innominata* Hume (Hume's Swiftlet), *C. francica* Gmelin (the Grey-rumped Swiftlet) and *C. linchi* Horsf. (Horsefield's Swiftlet) are found in the Andamans, Tennasserim, the Malayan Peninsula and the Mergui Archipelago.

On the west coast of India, the best known nesting places of *C. fuciphaga* are Pigeon Island, 15 miles north-west of Bhatkal (North Kanara); Sacrifice Rock, 20 miles south of Tellicherry; and Vengurla Rocks or 'Burnt Islands' (Ratnagiri dist.). The trade in birds' nests from these islands was at no time considerable, but is now practically extinct.

Nests of the Grey Swift (*C. francica*), which produces the best quality 'white' edible nests, are found in numbers in caves of islands in the Mergui Archipelago, specially in the Moscos group, the Mali group, the Ye-e group and the Turrets. A few nests are also obtainable from islands off the Bassein coast. The best qualities are exported to Peking. Collection is carried out by a monopolist, who has in the past paid as much as Rs. 20,000 for his rights, but the revenue has now dropped to about half that amount (Rodger, 109).

The breeding season is mostly Jan.-May, beginning somewhat earlier in Burma than on the west coast of India. The nests are tiny half-saucers in shape, about 3″ × 2″ and are found attached to

the sides and ceilings of caves and grottoes in the form of little cantilever brackets. Both sexes build nests using inspissated saliva. The salivary glands of the birds undergo special development during the breeding season. They begin to revert to normal soon after the first nest is completed. When these nests are removed, the birds build again, but this time there is some admixture of feather, and straw in the fabric. The third nest, built when the second is also taken, has an even greater admixture of impurities. In most collecting areas, the birds are left in peace after the third crop is gathered, giving them the opportunity to lay their eggs and to bring up their families in the fourth nest which is practically worthless.

The best quality nests of *C. francica* and *C. fuciphaga* are made entirely of inspissated saliva and are highly valued ($12-40 per lb.; Reese, 214). They are white or of a pale cream colour, partially translucent, resembling isinglass in appearance. The best and whitest nests are generally built in the inner caves in almost complete darkness. The nests of *C. innominata* and *C. linchi* are composed largely of feathers and straw glued together by saliva. They are known as 'dark' nests and are practically valueless, but are said to have a limited demand in Penang, Singapore and Burma.

The only considerable market for edible birds' nests has been, and still is, China. The principal centre of import and distribution is Hongkong. After being cleansed of adhering feathers and impurities, the nests are stewed into a soft mucilaginous jelly or thick soup. They are considered a great delicacy by the Chinese, and are also said to possess high medicinal, dietetic and tonic properties. They are composed of highly nitrogenous material containing nearly 50% of protein and 7·5% of mineral matter, mostly lime (*J. Siam Soc., Nat. Hist. Suppl.*, 1936, **10**, 2). Owing to the high prices fetched by birds' nests, the Japanese introduced faked birds' nests prepared from agar-agar. They compete favourably with the genuine article and can be detected only by connoisseurs.

Birthwort, Bracteated, see **Aristolochia bracteata**

" **Indian**, see **Aristolochia indica**

BISCHOFIA Blume EUPHORBIACEAE

A genus with only one species of a timber tree, distributed from India to Polynesia.

B. javanica Blume

D.E.P., I, 454; Fl. Br. Ind., V, 344; Beddome, Pl. 259.

HIND.—*Paniala*; BENG.—*Kainjal*; MAR.—*Boke*; TEL.—*Nalupumushti*; TAM.—*Thondi*; KAN.—*Gobranerale*; MAL.—*Nira*, *thirippu*; BURMA—*Tayokthe*; TRADE—Bishop wood.

A large deciduous or evergreen tree, with a cylindrical bole, reaching up to 25′ in height and 12′ in girth. It is found in shady ravines and river-banks of the sub-Himalayan forests from the Ravi eastwards, through Oudh and Gorakhpur to Bihar, Bengal and Assam; and in the Deccan peninsula on the Eastern Ghats, especially in Orissa and the Northern Circars, and on the West Coast, from Konkan southwards to the Nilgiris. It is a common tree in the forests of Burma and the Andamans.

For artificial regeneration, best results are obtained by raising seedlings and transplanting them, when they are 3–4 months old. The growth is fast and the tree can stand moderate shade and mild frosts. It coppices well.

Its seeds contain a drying oil: $d_4^{15°}$, 0·9199; $n_D^{15°}$, 1·473; sap. val., 192·3; iod. val., 145·27; acid val., 3·76 (Kafuku, Ikeda & Hata, ex *Chem. Abstr.*, 1933, **27**, 201). The leaves are reported to contain vitamin C, 136 mg./100g. (Yamamoto, Hara & Nisizawa, *Chem. Abstr.*, 1941, **35**, 1832).

The twig-bark contains: tannin 16; non-tannins, 13% (*Indian For. Leafl.* No. 72, 1944, 57). The wood has a dull-red or reddish-brown colour, sometimes with a dark-purplish tinge, and a strong scent of vinegar, when first exposed. It is moderately heavy (sp. gr., approx., 0·74; air-dry wt., 47 lb. per c. ft.), straight or shallowly and irregularly interlocked-grained. Anatomically, it is characterised by the absence of growth rings, large to medium-sized vessels borne for the most part in radial rows of 2–3, abundant coarse tyloses with gummy inclusions, very sparse paratracheal parenchyma, long unusually coarse thick-walled septate fibres in radial rows, and heterogenous rays of two sorts which form a relatively high but inconspicuous fleck on the quarter (Pearson and Brown, II, 883).

Bishop wood is easy to kiln-season, but, if it has to be air-seasoned, considerable care should be taken to protect it from rapid drying. It has a

tendency to warp and crack. It is nearly as hard as teak and is equal to it in shear strength, but in other respects it has only about 75–80% of its strength. Bishop wood is moderately durable, but it will survive for a longer period, if treated with preservatives. The sapwood readily absorbs 4–5 lb. of preservative per c. ft., but the heartwood is very refractory with only skin-deep absorption. The timber is not difficult to saw and works to a fine finish. It takes good polish (Trotter, 1944, 57).

Bishop wood is chiefly used for constructional purposes, such as bridges, house-posts, rafters, etc. It is a good sleeper wood, when treated. Sleepers, treated with creosote and laid in Assam lasted 15 years. Untreated ones are not likely to last for more than 4–5 years. Selected planks could be used for furniture. (Pearson and Brown, *loc. cit.*). The wood is suitable for making cheap pencils (*Indian For. Leafl.*, No. 66, 1945, 5). It is a good fuel wood (cal. val. of completely dry heartwood, 5162 cals. and ash, 1·28%—*Indian For. Bull.*, *New Series*, No. 79, 1932, 12).

Bengal and Assam are the main sources of this timber. The Buxa division in Bengal yields 7,800 c. ft., whereas Assam can produce 400–500 tons per annum. Limited supplies are also available in Madras. In Bengal, the price used to vary in pre-war years (1937) from Rs. 20–30 per ton and in, Madras from Rs. 27–34 per ton in the log (Trotter, *loc. cit.*).

Bishop's Weed, see **Trachyspermum ammi**

BISMUTH ORES

Bismuth occurs native and in the form of its sulphide, bismuthinite, Bi_2S_3 (Bi, 81·2%; sp. gr., 6·45; H., 2), but its occurrences are not very common. Bismuthinite is lead-grey in colour and occurs massive or in the form of needle-like crystals. Indian occurrences (Bihar, Kangra and Sikkim) are not of any economic importance.

In Burma, both native bismuth and bismuthinite, occur in cassiterite-wolfram veins at Kanbauk (14° 35′: 98°2′), Kalonta (14°17′: 98°17′), Zinba (14°38′: 98°11′) and Putletto (14°4′ : 98°30′) in Tavoy dist. They are also found in Mergui and Amherst dists. (*Bull. Indian Industr. Lab.*, 1921, **6**, 24). These veins, in addition, contain small quantities of molybdenite, pyrite, pyrrhotite, copper pyrite, galena and zinc blende. The amount of bismuth, however, is too small to be profitably worked. But native bismuth has been recovered as a by-product from the detrital deposits of wolfram and cassiterite.

In these deposits, bismuth fragments are always found decomposed and are likely to be mistaken for pebbles of grey slate. But they have a high density, and when broken, often show a kernel of unoxidised metal. A simple field test for the recognition of bismuth is to dissolve a fragment in sufficient hydrochloric acid; on dilution with water, the solution will turn milky, due to the formation of insoluble basic compounds. These redissolve on the addition of more acid.

In Burma, bismuth ores are either hand-picked from tin-wolfram concentrates obtained after sluicing operations, or recovered from tin ore by magnetic separation. They are not smelted locally, but are exported to the U.K. The production of native bismuth in Burma is small (246 lb. in 1937). The world's annual production of bismuth is about 1,500 metric tons and most of this bismuth is obtained as a by-product in the smelting of ores of other non-ferrous metals.

Bismuth is produced by the reduction of its oxide into which the other ores are converted. During refining, it is freed from the common impurities such as lead, arsenic and antimony. Bismuth is a bright hard and somewhat brittle metal (sp. gr., 9·8 ; m.p., 217°). It is greyish-white with a reddish tinge. It expands after solidification by about 2·3% of its volume. Along with other metals like lead, tin, cadmium and antimony, bismuth is a constituent of fusible alloys, which are employed in automatic fire-extinguishers, fuses for hand grenades, safety plugs for boilers, etc. It is also used in stereotype alloys, and in dentistry for the making of dies from fresh plaster impressions. Bismuth alloys are also used as soft solders, and as fillers in bending tubes, and in mouldings. Bismuth amalgam is used for the silvering of mirrors and the interior of vacuum flasks.

Some of the compounds of bismuth, the oxy-carbonate, the subnitrate and the subgallate are largely used in medicine for digestion troubles. Bismuth oxide has been used as a constituent of optical glass and for colouring porcelain. The subnitrate is used to give a colourless iridescent glaze to porcelain. Bismuth trichloride has been used as a fire-proofing material.

Bitter-sweet, see **Solanum dulcamara**

BIXA Linn. BIXACEAE

A genus of two species of shrubs or small trees, native to tropical America and the West Indies. *B. orellana* has become naturalised in India, and is the source of the orange-red dye 'annatto'.

B. orellana Linn.

D.E.P., I, 454; Fl. Br. Ind., I, 190; Pl. XXXI.

HIND. & BENG.—*Latkan*; MAR.—*Sendri*; TAM. & TEL.—*Japhara*; KAN.—*Rangmale*.

This species occurs in two forms, one with white flowers and green capsules, and the other, with pink flowers and red capsules. Each capsule contains about fifty small seeds, the pulpy outer covering of which contains pigments. The plant is a native of central America and is cultivated in Brazil, Guiana (Cayenne), Mexico and the Antilles. In India, it is reported to be cultivated to a small extent in Mysore (Yegna Narayan Aiyer, 500) and is grown in gardens as a hedge plant. It is also met with as an escape, in Travancore, Coromandal and Malabar Coasts and in certain districts of Bombay, Bengal and Assam.

The plant is propagated either from seeds or from stem-cuttings. It cannot withstand frost. Fruits are produced from about the third year after planting, and are collected when nearly ripe.

For extracting the dye, the seeds are bruised and the pulp macerated with hot water, in wooden vessels, and soaked in it for several days till the colouring matter forms a fine suspension. The seeds are then removed, and the *brei*, which contains the pigment, is allowed to ferment for about a week. The dye, annatto, that settles at the bottom is separated and dried into cakes. The yield is 4·8–6% by wt. of the seeds. Another method consists in boiling the seeds with sodium carbonate solution, filtering, and acidifying the filtrate. The dye is coagulated by boiling with common salt, after which it is filter-pressed, washed, and dried (*J. sci. industr. Res.*, 1942, **1**, 63). Annatto, produced in South America, is marketed in the form of cakes, tablets or as a paste. Solutions of the dye have also been introduced by the trade.

Bixin, $C_{25}H_{30}O_4$, the principal colouring matter present in the seeds, is accompanied by small amounts of orellin, a water soluble yellow substance, fat, resin, and a bitter stuff. Bixin, when crystallised from glacial acetic acid, is obtained in the form of rhombic needles, m.p., 198° (*Helv. chim. Acta.*, 1929, **12**, 904). It is fairly soluble in chloroform, ethyl acetate, and alcohol, but is insoluble in water. Both bixin and annatto are soluble in essential oils and in fixed oils. They are also soluble in alkalis and are precipitated by acids.

The proportion of bixin in annatto varies considerably. It is usually 10–12%, but special grades containing up to 15–30% are also known. The dye is related to carotenoids but has no pro-vitamin A activity (Villela, *Chem. Abstr.*, 1943, **37**, 224).

The seeds contain only a small amount of fatty oil (Aiyer, *J. Amer. pharm. Ass.*, 1922, **11**, 999; *vide* also Froiso, *Chem. Abstr.*, 1935, **29**, 2301). The seed-coat contains a wax-like substance (3%) which paralyses intestinal parasites, and the embryo, a toxic principle (Froiso, *loc. cit.*).

Annatto was once used for colouring silk and cotton, but it is not a fast dye and has now been replaced by coal-tar dyes. On account of its non-toxic nature, it is now mainly used for colouring edible materials like butter, ghee, margarine, cheese, chocolate, etc. The colouring of *vanaspati* (hydrogenated vegetable oil) by annatto may serve to distinguish it from ghee (*J. sci. industr. Res.*, *loc. cit.*). Recipes have been worked out for using it in floor polishes, shoe polishes, hair oils, etc. (Tanchico and West, ex *Chem. Abstr.*, 1937, **31**, 4874).

Small quantities of seeds are exported from south India (87 tons in 1939-40) which is estimated to produce about 200 tons of seeds per annum. However, the bulk of annatto used in the dairy industry in India is imported from America.

Black-berry or **Bramble**, see **Rubus fruticosus**

Black cumin, see **Nigella sativa**

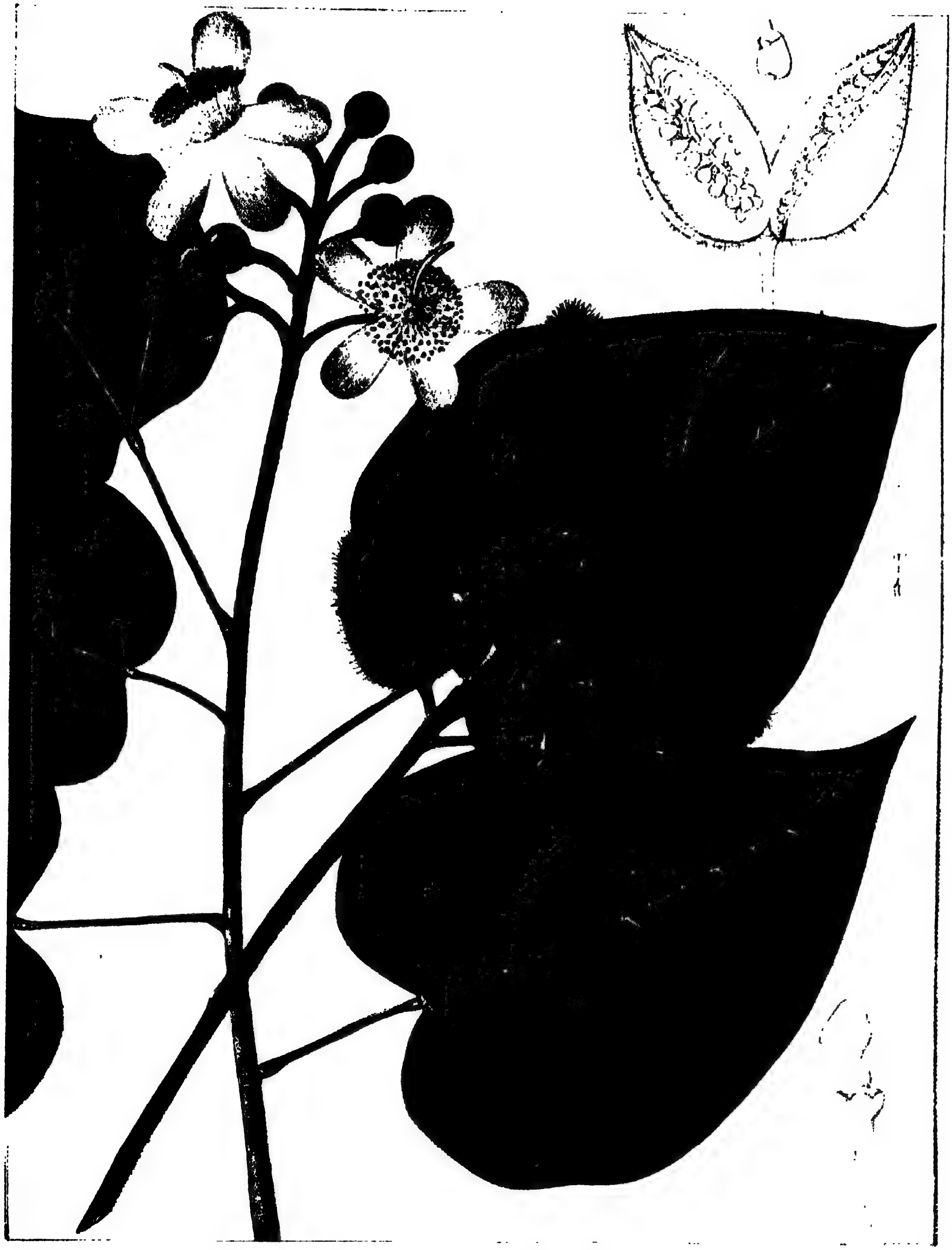
Black lead, see **Graphite**

Black wattle, see **Acacia mollissima**

Black wood, Australian—, see **Acacia melanoxylon**

BLECHNUM Linn. POLYPODIACEAE

A genus of ferns, including about 60 species, distributed in tropical countries. *B. orientale* Linn.



BIXA ORELLANA

is a tufted fern, found in the Himalayas up to 4,000′, and in the south Indian mountains up to 6,000′. The Malays eat it, and poultice boils with it (Burkill, I, 333).

BLEPHARIS Juss. ACANTHACEAE

The genus includes 80 species of shrubs or undershrubs, distributed in Palaeotropics, the Mediterranean region and S. Africa. 5 species are found in India.

B. edulis Pers. and *B. linariaefolia* Pers. (syn. *B. sindica* T. Anders.; Fl. Br. Ind., IV, 479), found in the Punjab and Sind, are of minor medicinal value. The former is reported to be a resolvent and expectorant (Chopra, 468).

Lal (*J. Indian chem. Soc.*, 1936, **13**, 109; 1940, **17**, 269) found the seeds of *B. edulis* to contain allantoin (2·1%), and blepharin, $C_{16}H_{20}O_{10}$, m.p., 222°, a glucoside. The benzene extract gave 3·8% of a fatty oil (sp. gr./28°, 0·9332; sap. val., 186·5; iod. val., 90·8. Pendse and Lal, *ib.*, 1937, **14**, 262).

Blinding Tree, see **Excoecaria agallocha**

Blubber Oil, see **Whales**

Blue gum, see **Eucalyptus globulus**

BLUMEA DC. COMPOSITAE

A genus of 80 species of annual or perennial herbs, sometimes shrubs, distributed in the tropics of Asia, Africa and Australia. The genus is eminently characteristic of India, where about 35 spp. occur. Many of them are aromatic and medicinal. *B. balsamifera*, *B. densiflora*, *B. eriantha*, *B. lacera* and *B. malcolmii* yield essential oils.

B. balsamifera DC.

D.E.P., I, 458; Fl. Br. Ind., III, 270; Kirt. & Basu, Pl. 522 B.

HIND.—*Kakaronda.*

A sub-shrubby plant, distributed in the tropical Himalayas from Nepal to Sikkim between 1,000–4,000′, and extending to Assam, Khasia Hills, Chittagong, Burma, and the Philippines.

The plant smells strongly of camphor and the leaves yield an essential oil containing a camphor known as Ngai or Blumea camphor. Philippine plants are reported to yield 0·1–0·4% of oil (Finnemore, 829). Puran Singh (*Indian For. Rec.*, 1908, **1**, 265) found plants of Burmese origin (leaves and roots) to contain 1·9% (on dry weight) of oil.

Ngai-camphor from Chinese sources is almost entirely *l*-borneol; camphor of Burmese origin consists of 75% of *l*-camphor and 25% of *l*-borneol (Wehmer, II, 1220).

Ngai-camphor also finds medicinal uses like Borneo camphor, *d*-borneol, from *Dryobalanops aromatica* Gaertn. occurring in Sumatra and Borneo.

An injection of the extract of leaves produces a drop in blood pressure, dilation of the vessels and inhibition of the sympathetic nervous system. It is used in the treatment of excitement and insomnia (Leclerc, *Chem. Abstr.*, 1941, **35**, 2981). The leaves are reported to be used as fish poison in the Philippines (Brown, II, 222).

B. densiflora DC.

D.E.P., I, 458; Fl. Br. Ind., III, 269; Kirt. & Basu, Pl. 521 B.

A stout herb, distributed in the sub-tropical Himalayas from Sikkim to Assam between 2,000–4,000′.

The plant yields an essential oil containing camphor (Wehmer, *loc. cit.*).

The juice of fresh leaves possesses insect-repellant properties (Chopra, Roy and Ghosh, *J. Malaria Inst., India*, 1940, **3**, 495). When rubbed on the skin, it affords protection from mosquito bites till the volatile oil evaporates off (10–15 minutes).

B. eriantha DC.

D.E.P., I, 458; Fl. Br. Ind., III, 266; Kirt. & Basu, Pl. 522 A.

MAR.—*Nimurdi.*

An erect herbaceous plant, distributed in the Konkan, the Western Ghats and the Deccan, and very common in Bombay.

It yields an essential oil possessing camphor-like smell (b.p., 224°; sp. gr./31°, 0·9290; sap. val., 34·5. Amin and Patel, *J. Indian chem. Soc.*, 1940, **17**, 45), consisting chiefly of *d*-carvotanacetone. Erianthin, $C_{20}H_{20}O_{5}$, m.p., 161°, the yellow colouring matter obtained from it (0·02–0·03% of the air-dry plant), has been shown to be a flavone (Bose and Dutt, *J. Indian chem. Soc.*, 1940, **17**, 45).

B. lacera DC.

D.E.P., I, 459; Fl. Br. Ind., III, 263; Kirt. & Basu, Pl. 521 A.

Sans.—*Kukuradru*; Hind.—*Kakranda*; Beng.—*Kukursunga*: Mar.—*Burando.*

An erect annual, with a strong odour of turpentine distributed throughout the plains of India, ascending to 2,000′; also in Ceylon, China and Malaya. It is used as a febrifuge, deobstruent and stimulant (Kanny Lall Dey, 47).

The herb gives 0·085% of essential oil, containing Blumea camphor (Wehmer, *loc. cit.*).

B. malcolmii Hook. f.

Fl. Br. Ind., III, 266.

A stout herb, distributed in the Konkan on hills above 2,000′, also in South Kanara, and Malabar.

It yields an essential oil with the following constants; $d/30^{\circ}$, 6·93; $n_D{}^{30^{\circ}}$, 1·475; $[\alpha]_D{}^{30^{\circ}}$, +46·8°; containing 82% of *d*-carvotanacetone, and 16% of tetrahydrocarvone (Simonsen and Rau, *J. chem. Soc.*, 1922, **121**, 876).

BOEHMERIA Jacq. — Urticaceae

A genus consisting of 75 species of herbs, shrubs, or small trees, distributed in tropical and northern sub-tropical areas. There are about 10 species native to, or naturalised in India, and most of them yield fibre. Of these, *B. nivea* is the most important. The fibres of *B. macrophylla* D. Don *B. malabarica* Wedd. and *B. platyphylla* D. Don are used locally for cordage and fishing lines.

B. nivea Gaud. — China Grass, Rhea, Ramie

D.E.P., I, 468; C.P., 143; Fl. Br. Ind., V, 576.

Beng.—*Kankura*; Assam—*Rhea*; Burm. *Gun, goun*; China—*Schou* (the plant) and *Schou-ma* (the fibre).

A shrub 3–7′ high, indigenous to China and Japan and now introduced into southern U.S.A. It is cultivated in some parts of India. In Bengal, it is a garden crop, and in Assam it is grown as a scattered crop over some 1000 acres (Sircar, 58).

The plant has two distinct varieties—*nivea* proper (Rhea), with leaves that are green above and whitish beneath, and *tenacissima* (Ramie), with leaves green on both sides. Var. *nivea* belongs to somewhat cooler climates than the other.

Plants can be raised either from seeds, or preferably from root and stem-cuttings. The root sylstem is perennial and gives rise to abundant fresh shoots after each cutting of stems. If properly cultivated, no replanting is necessary for about six years. The usual time for transplantation is either April–May, or September October. From the April–May transplantations, 2 or 3 cuttings may be obtained during rains, when growth is luxuriant. From plants transplanted in September, four cuttings may be obtained during May–August.

The stems become mature in 10 months and change colour, from green to brown. For obtaining fine, soft fibre, shoots must be cut before they mature and begin to flower. The quality of fibre depends on the age and length of shoots. Shoots not more than 2′ in height give very fine fibre, but the quantity obtained is small. In long stems the fibre is coarse. Shoots, 3½–4′ high, yield good fibre in normal quantities.

The first cutting is used as green manure, because it yields very poor fibre. In Assam, the plants are found to thrive better, and more cuttings can be obtained than in Bengal.

The crop thrives on a rich loamy soil, and is of an exhausting nature. Heavy manuring at frequent intervals is necessary. The land must be above the height of prolonged inundation, but there must be free sub-soil moisture. Red clay soils are not suited to this crop.

The cut stems are decorticated by hand as in India and China, or by machinery as in America, and the fibre is stripped off. Retting does not yield satisfactory results. The crude fibre is heavily coated with gum which is removed by treatment with soap solution or lime. Steaming might also be resorted to. The resulting clean fibre is called 'filasse'.

Ramie contains: moisture, 10·5; cellulose, up to 65·9; lignin, *ca.* 1·46% (Wehmer, I, 254). The fibre is regarded as the longest (40–200 mm.), toughest, and most silky of all vegetable fibres. It has great strength and durability, and is highly resistant to the action of water. But it has neither the elasticity of wool and silk, nor the flexibility of cotton. The spun thread is hairy because the ends of the stiff fibres project out.

Ramie is used in Europe for sacks, sail cloth, bolting, table-cloth, sheeting, nets, threads, cordage, paper, etc. Gas mantles of good quality are also made from it. Ramie is rarely used by itself in textiles, but is mixed with wool, silk and cotton. Its special use is in the preparation of lustrous, non-creasable fabrics. On account of its high resistance to the action of water, fabrics containing this fibre shrink only slightly. The hairiness and brittleness of thread spun out of ramie fibre is considerably reduced by mercerisation.

The average annual yield of fibre is 500-600 lb. per acre and it is valued at about Rs. 70 per cwt. The price is not considered remunerative. The cost of production is high, because of the necessity for frequent manuring of the crop, and the absence of suitable machinery for the extraction of fibre.

B. rugulosa Wedd.

D. E. P., I. 484; Fl. Br. Ind., V. 577.

GARHWAL & KUMAON—*Geti*; NEPAL—*Dar*; BENG. & LEPCHA—*Sedeng*.

A small tree, met with in Garhwal, Kumaon, Nepal, Sikkim and Bhutan.

The wood is light (air-dry wt., 32 lb. per c. ft.), straight grained, and moderately hard. It seasons well, works readily under tools, and is rarely attacked by insects or fungi. It is used for making bowls, plates, and other domestic utensils (Pearson and Brown, II, 947).

BOERHAAVIA Linn. NYCTAGINACEAE

A genus consisting of 40 species of weeds, distributed in tropical and sub-tropical regions. Six species are found in India.

In some parts of India, the Ayurvedic drug *punarnava* is referred to as *B. diffusa*, and in others as *Trianthema portulacastrum* (Aizoaceae). According to Chakravarty (*J. Indian bot. Soc.*, 1942, **21**, 87) *B. diffusa* should be called *rakta punarnara* on account of its pink flowers, and *T. portulacastrum* with its white flowers *swet punarnara*. Although they belong to different families, they are used for the same medicinal purpose, and the chemical constituents are also similar (Chopra, Chatterjee and Ghosh, *Indian J. med. Res.*, 1940, **28**, 475).

B. diffusa Linn. Syn. *B. repens* Linn.

THE SPREADING HOG-WEED

D. E. P., I. 485; Fl. Br. Ind., IV. 709.

SANS., BENG. & TEL. *Punarnava, rakta punarnava*; HIND. *Sant*; MAR. *Tambadi vasu*; GUJ.—*Vakha khaparo*; TAM.—*Mukaratte-kirei*.

A perennial creeping weed, with pinkish flowers, found throughout India.

The root of the plant is considered laxative and diuretic. It has also expectorant properties and is used in asthma. In large doses, it acts as an emetic (Kanny Lall Dey, 48). Koman (1919, 141; 920, 3 & 40) found it to be a fairly good diuretic, especially when combined with iron, in dropsy associated with chronic Bright's disease.

The active constituent of the drug is the alkaloid, *punarnavine*, the total alkaloid content of roots being about 0·04% (Chopra, Ghosh and De, *Indian med. Gaz.*, 1923, **58**, 204; *vide* also Agarwal and Dutt, *Proc. U. P. Acad. Sci.*, 1934-35, **5**, 240). The plant is also reported to contain a crystalline acid of the formula, $C_{10}H_{18}O_3$, m.p., 108-109° (Agarwal and Dutt, *ib.*, 1934, **4**, 73). According to Chopra, Chatterjee and Ghosh (*Indian J. med. Res., loc. cit.*) the dry plant contains 0·52% of potassium nitrate.

Intravenous injections of the alkaloid in cats produce a distinct and persistent rise of blood pressure and a marked diuresis. Clinically, 1–4 drachms of liquid extract made from the dry or the fresh plant, produce diuresis in cases of oedema and ascites. When a liquid extract is used, the presence of large amounts of potassium salts reinforces the action of the alkaloid. The drug appears to exert a more powerful effect than some other diuretics on certain types of ascites, such as those due to early cirrhosis of liver and chronic peritonitis (Chopra *et al.*, *Indian med. Gaz.*, 1923, **58**, 203)

Bombax Linn., see **Salmalia**

BONES

D.E.P., V, 171; C.P., 169.

SANS.—*Asti*; PERS.—*Ustokhan*; ARAB.—*Izm*; HIND. *Haddi*; BENG. *Harh*; TAM. & MAL.—*Elumbu*; TEL. *Emukalu*; KAN.—*Moole*.

Bones are the most highly differentiated of the connective and supporting tissues of Vertebrata. In typical long bones (femur and humerus) the shaft consists of compact bone and contains in its

centre a large, cylindrical cavity filled with marrow. The ends of the shaft are formed of spongy bone with a thin peripheral cortex of compact bone.

Bones consist of two main components: an organic framework, and an infiltrate mass of inorganic salts. Fresh bones contain: moisture, 51; fat, 15·7; ossein, 11·4; and mineral matter, 21·9% (Bogee, 88). Degreased bones contain: fat, 6; ossein, 28; calcium phosphate, 56; magnesium phosphate, 1; calcium carbonate, 8; and calcium fluoride, 1% (Kingzett, 115).

Bones are collected all over India, mostly during the dry season, and reach wholesale merchants through bone dealers. Generally, the quality is not high, and they are seasoned in primitive ways by exposing them in heaps to sun, air and rain, in open spaces protected against carrion-eaters. A few months later they are dried after the removal of adhering flesh and grease. Sometimes bones are also seasoned by placing them in ditches to which water is added every third or fourth day. They are removed after about a month and dried in the sun for a few days. In some places, bones are buried underground for about a week and then dried (Haq, *Indian Fmg.*, 1945, **6**, 458).

Bones are generally more abundant in northern India. The annual production in India is estimated to be 1,391,000 tons (Haq, *loc. cit.*). Out of these, only a small proportion is collected for commercial use. In the absence of any detailed survey, the exports of bones (internal movement) from different Provinces, and to ports within Provinces, may serve as an index of their distribution and availability.

INLAND TRADE (EXPORT) IN BONES '36/37

[*Inland (Rail & River-borne) Tr. India*]

	Tons*
Bihar and Orissa	14,000
Central India	3,096
C. P. & Berar	8,644
Hyderabad	7,230
Mysore †	1,200
Rajputana	15,000
Punjab	31,000
Sind & Br. Baluchistan	900
U. P.	28,780
Bengal to Calcutta	11,375
Bombay Province to Bombay	11,250
Madras Province to Madras	10,464
Total exports from India	131,526

*The figures also include re-exports; † Handbook of Commercial Information for Mysore, 1941, 77.

In India, a small quantity of long bones is used for the manufacture of utility articles such as combs, buttons, toys, knife-handles, etc., and in bone-carving (Pl. XXVII, 4). Camel bones are preferred for making buttons. It is often difficult to distinguish between articles made of bone and ivory. Bone being more porous is stained by oil more readily than ivory.

For use in bone-work, the ends of leg and thigh bones are sawn off and the cylindrical portions, after the removal of marrow, are immersed in lime solution for about a day and boiled in it for some time. The pieces are then washed with water and dried in shade. During washing, the inner cavity is cleaned with a brush and the outer surface smoothened with rags (Haq, *loc. cit.*).

BONE-CRUSHING & BONE MANURE (Pl. XXVII, 2)

Before the War ('39-45), in India, superphosphate was the only product made from bones, and annual production was about 3,000 tons utilizing a slightly larger quantity of bones. In very recent years production of this has been stepped up to about 15,000 tons. Further, since the commencement of the War, a small amount of phosphoric acid and its salts are being manufactured from about 150 tons of bones per annum. Excepting these quantities, almost the entire amount of bones collected is exported.

Bone-crushing for export is a well-established industry. As far back as 1900, there were 18 bone mills in India, and now there are 27 mills in British India and some 4 or 5 in Indian States, employing about 4,500 persons, and with a crushing capacity of over 400,000 tons. Most of these mills are situated near ports.

Bone mills use disintegrators or cutters for reducing the size of bones. The finer varieties constitute bone meal (3/32") and bone grist (3/16"), and the larger varieties are graded into sizes varying from 3/8" to 1½". The yield of bone meal is only a fraction of bones crushed. With disintegrators, it is about 25%, and with cutters 5-8%. The cost of crushing and bagging is now (1947) about Rs. 60 per ton.

During crushing, bone sinews (yield, 7%), consisting of pieces of tendons or ligatures attached to the ends of bones, separate out in fibrous pieces,

These are used for the manufacture of glue and gelatine, and about 1,000 tons are exported annually.

Bone meal is a valuable phosphatic manure, but its action in the soil is rather slow owing to the insolubility of calcium phosphate. It has the following composition: organic matter, 30·6; phosphoric acid, 24·2; lime, 32·0; other inorganic constituents, 4·7% (Thorpe, II, 27). It is also used as poultry-feed, and certain special grades, nearly white in colour and almost odourless, are used for feeding horses. In India, only a small quantity of bone meal is used as manure in plantations, and most of the produce is exported.

Steamed bone meal is prepared from bones treated with steam (50 lb. pressure), when nitrogenous constituents separate out as glue or gelatine. It is sterile, and its phosphoric acid is said to be more easily available than that of unsteamed bone meal.

ANALYSIS OF BONE MEAL*
(Per cent.)

	N	P_2O_5
Raw bones	5	22
Bone meal—unsteamed . .	3.5 4·5	20–25
Bone meal steamed . .	1–3	25–32

*Parrish & Ogilvie, I, 267.

Bone grist (3/16″) is used for making bone char, and for the manufacture of glue and gelatine. It is also used as chicken-feed. Crushed bones of sizes above 3/16″ are used only for the extraction of glue and gelatine.

Bones are among the valuable raw materials exported from India. In years prior to the War, the total annual exports averaged to nearly 95,000 tons valued at about Rs. 70 lakhs, and touched a peak of 131,526 tons in '36-37. During the War, exports dwindled considerably and touched the lowest level in '43-44 (28,684 tons).

During the quinquennium ending '38-39, Belgium, the chief purchaser, took 75·7% of Indian exports of bones for manufacture, and for manure. The principal purchasers of bone meal were the U.K. (40%) and Ceylon (36%). Exports were mostly from the ports of Bengal (52%), Sind (26%) and Madras (14%). The share of Bombay was small (7%).

Since 1946, exports of uncrushed bones and bone meal have been prohibited. The maximum quantity of crushed bones and bone grist permitted for export in '47 was fixed at 40,000 tons.

The following table gives the prices of bones (per ton) in collecting centres, 400 miles west of Calcutta.

	Rs.
'39	31–38
'40	29–49
'41	31–39
'42	26–41
'43	41–52
'44	52–70
'45	75–110

Prices have risen abnormally in recent years owing to increased cost of collection, which is now nearly Rs. 30 per ton. Quotations in internal markets are based on those prevalent in the Calcutta market, which in turn reflect changes in demand abroad. In March '47, Calcutta quotations were Rs. 192 per ton, and since then fluctuations have been violent.

PRICES (PER TON) OF BONE MEAL AND GRIST
(*Indian Tr. J.*)

Year	Bone meal (2/32″) Steamed	Bone meal (2/32″) Unsteamed	Bone grist (3/16″) Unsteamed
	Rs.	Rs.	Rs.
'38 . .	90–100	52–55	58–60
'43 . .	95–140	85–135	85–135
'46 . .	200–210	170–200	190–200

EXPORTS OF BONES
(Qty. in 1,000 tons; val. in lakhs of Rs.)

Annual average	Bones for manufacture Qty.	Bones for manufacture Val.	Bones for manure Qty.	Bones for manure Val.	Bone meal Qty.	Bone meal Val.	Total Qty.	Total Val.
In quinquennium ending—								
'33-34	52·9	50·17	2·4	2·25	29·2	20·86	84·5	73·29
'38-39	54·5	35·63	20·7	16·03	30·1	15·79	105·3	67·42
'43-44	21·1	13·70	4·9	3·40	28·5	17·03	54·5	34·19
In '44-45	21·4	18·07	1·2	1·66	10·3	8·59	32·9	28·34
" '45-46	41·2	43·43	5·6	6·36	10·5	9·11	57·3	58·84

Before the War, steamed bone meal used to fetch Rs. 30–35 per ton, more than the unsteamed variety, and bone grist (3/16″), a higher price than unsteamed bone meal, as it could be used for the recovery of gelatine.

Attempts are being made to develop the bone industry in India to meet the country's requirements of phosphatic fertilizers estimated at 100,000 tons per annum. But bones can only be economically employed for the production of superphosphate if by-products, such as glue and gelatine, are also recovered. Otherwise, the cost of production of superphosphate will be high, and valuable by-products will be wasted.

It is estimated that the value of imported superphosphate prepared from mineral phosphates is now Rs. 130–160 per ton, while the cost of manufacture of superphosphate from bones in India is approximately Rs. 200, owing to the high prices of bones and sulphuric acid. The difference can be made up only if bones are processed to yield glue, gelatine, etc., before being utilized for conversion into phosphatic manures.

OTHER PRODUCTS FROM BONES

Bone fat, also called bone tallow, is extracted from fresh clean bones by boiling them with water, by steaming them, or by solvents. It has the following constants: solidifying point, 15°–17°; sp. gr./15·5°, 0·914–0·916; sap. val., 185–195; iod. val., 43–56 (Hilditch, 136). It yields nearly 40% of palmitic and stearic acids, the rest consisting of oleic acid. It is mainly employed for making candles and low grade soaps, and as a grease. In India, bones are received mostly dry, and contain very little fat or marrow.

Crude glue may be extracted from defatted bones by digesting them with steam. The liquor obtained is concentrated and allowed to solidify. A more valuable product is ossein (yield, 30%), which is obtained by dissolving out the mineral constituents of bones by means of dilute hydrochloric acid. It retains the original shape of bones, and consists of the organic constituents present in them. Ossein is the raw material for the preparation of better grades of glue and gelatine. It is mostly produced in Belgium and exported to America where there is a heavy demand for it.

Bone-black or bone-char is obtained in a yield of 60% by the destructive distillation of fresh hard bones, after the removal of fat and other extraneous matter. Its chief constituents are: carbon, 9–11%; calcium phosphate, 70–75%; other mineral matter, the rest (Rogers, 1, 722). Bone-black has a high degree of porosity and gives a metallic ring when struck. It is extensively used as an adsorbent and decolorizing material, especially in the sugar industry. In India, there is a prejudice against its use.

In certain types of bone-black, the mineral constituents are removed, either partly or wholly, by treatment with acids. Bone-black, after repeated use, loses its activity and can be revivified by roasting it to a red heat. When of no further use, the spent material is used as a paint pigment, and as fertilizer.

During the destructive distillation of bones, bone oil (3–5%), also called Dippel's oil, and ammonia (8%) are obtained as by-products. The latter is converted to the sulphate. Bone oil (sp. gr., 0·91–0·97), a dark-brown liquid with a repulsive odour, is miscible with water. It consists of pyrrole and pyridine bases, and is used as a denaturant, and as an insecticide.

Bone ash, which is obtained by the calcination of bones, contains 87% of calcium phosphate. It is used as manure. In India, it is also being used for the preparation of phosphoric acid.

BONNAYA Link & Otto SCROPHULARIACEAE

Fl. Br. Ind., IV, 284.

A genus of 5 species of herbs, distributed in India, south-east Asia and Australia. Some botanists include these under other genera, such as *Ilysanthes* Rafin., *Vandellia* Linn., or *Lindernia* Allioni.

In Malaya, a decoction of the roots and leaves of *B. antipoda* Druce is taken as a vermifuge; and the juice of *B. serrata* Burkill is administered internally as a protective tonic for the first 3 days after child-birth (Burkill, I, 346).

Borage, country—see **Coleus amboinicus**

BORAGO Linn. BORAGINACEAE

Firminger, 439.

The genus includes 3 species, found in the Mediterranean region, Europe and northern Asia.

B. officinalis Linn. (Borage), a coarse hairy annual possessing very attractive blue flowers, is planted in Indian gardens. In Europe, it is cultivated for bee-feeding and is also used as pot-herb, or as salad (Hill, 495).

BORASSUS Linn. PALMAE

Borassus is a genus of four species of tall dioecious palms, distributed in the tropics of the Old World, and *B. flabellifer* is the only species found in India.

B. flabellifer Linn. Syn. *B. flabelliformis* Roxb.
THE PALMYRA PALM

D. E. P., I, 495 ; Fl. Br. Ind., VI, 482 ; Pl. XXXII, 1 & 2.

SANS. & BENG.—*Tal* ; PERS.—*Darakhte-tari* ; HIND.—*Tar* ; MAR. & GUJ.—*Tad* ; TEL.—*Tadi-chettu* ; TAM.—*Panai* ; KAN.—*Tale* ; MAL.—*Pana*.

B. flabellifer, a native of tropical Africa, is found in many of the comparatively dry parts of India, Burma and Ceylon, and is common along the coastal areas of the peninsula, Bihar, Bengal, and the northern portion of Ceylon. It is distributed to Malaya.

This palm attains a height of 40–60′ (sometimes even 100′) and a girth of $3\frac{1}{2}$–7′. It bears a terminal crown of 30–40 large fan-like leaves, 3–5′ in width. The leaf-stalks are 2–4′ long, strong and fibrous. The stem is black and consists of a hard outer portion mainly composed of stiff longitudinal fibres. The central portion, the pith, is soft and starchy.

The spathes begin to appear in November and December. Male and female flowers are borne on different plants. In both cases, a large quantity of sugary sap exudes when the inflorescence axis is tapped. The fruit is large and fibrous, containing usually 3 nut-like portions, each of which encloses a seed.

The plants develop from self-sown seed. In the earlier stages, only the underground portion of the stem increases in thickness, and 15–20 years elapse before the aerial portion of the trunk elongates and develops into its characteristic cylindrical black stem.

This palm also is attacked by insects which affect the coconut palm (*Cocos nucifera*) ; the rhinoceros beetle (*Oryctes rhinoceros* Linn.), the red palm weevil (*Rhynchophorus ferrugineus* Fabr.), the black headed caterpillar (*Nephantis serinopa* Meyr.), etc. (Ramakrishna Ayyar, 337). It is also liable to a fungus disease called ' bud-rot ', caused by *Pythium palmivorum*, which attacks the bud, eats into the growing point, and ultimately kills the tree (Troup, III, 974).

TODDY & *NIRA*

The palmyra is one of the palms yielding toddy, the country liquor. The other important palms, which are tapped for toddy, are *Phoenix sylvestris*, *Caryota urens*, *Nipa fruticans*, and sometimes also *Cocos nucifera*. The fresh sap of these palms, called ' sweet toddy ' or *nira*, contains about 12% of sucrose, and unless suitably treated, fermentation into toddy starts almost immediately after collection.

While *nira*, tapped from the palmyra tree, is transparent, pleasant-smelling, and sweet, toddy is a pale frothy liquid with a characteristic aroma, and a slightly acid and pungent taste. It is a cheap and refreshing beverage extensively used by the lower classes, and is a valuable source of revenue to the State. Its nutritive value depends on the small amounts of sugar and yeast in it. The latter is a good source of vitamin B complex. Chopra, Chopra & Chopra (*Indian med. Gaz.*, 1942, **77**, 224) have observed that in areas where the use of toddy is prevalent, vitamin B deficiency diseases are rare.

ANALYSIS OF PALMYRA TODDY*

	G. in 100 c.c. of sap				
	Total solids(%)	Sucrose	Reducing sugars	Acetic acid	Alcohol
Male trees .	6·2	1·90	0·51	..	2·01
Female trees .	5·8	1·87	0·46	0·40	3·14

* Joachim and Kandiah, *Trop. Agriculturist*, 1938, **90**, 22.

Spontaneous fermentation of the juice produces about 3% of alcohol and 0·1% of acids during the first 6–8 hours. After this, alcohol content increases to nearly 5%, and later begins to decrease, while the amount of acids continues to increase, rendering the liquid unsuitable for human consumption. Butyric acid has been detected among

the acids and this gives a disagreeable odour to the liquid (Basrur and Qureshi, *J. Osmania Univ.*, 1939, **7**, 19).

Some unused toddy is allowed to undergo acetic fermentation to yield a cheap quality of vinegar. On account of its yeast content, toddy is sometimes used in bread-making, but the resulting bread has an unpleasant odour.

Nira is a refreshing sweet drink and is also credited with medicinal virtues. It is used as a stimulant and antiphlegmatic, and is also considered useful in inflammatory affections and dropsy. Its use as a beverage is not likely to extend because of the difficulty in preserving it. But the recovery of sucrose contained in it, in the form of *gur*, has long been practised as a cottage industry in Madras. Sethi and Ghosh (*Dep. Agric., Bihar & Orissa, Bull.* No. 9, 1932) have suggested its extension into Bihar. Since palmyra sap is also a source of toddy, precautions will have to be taken against the misuse of permission granted for the preparation of *gur*.

TODDY TAPPING

In the southern districts of Madras, tapping is mostly in the hands of professionals who are usually small farmers (*Dep. Agric., Bombay, Bull.* No. 93 of 1919, 45). In some cases, the palms belong to them, but generally they hire them from landlords and are also required to take a licence from the Excise Department. The tapping season extends from February to May (about 90 days), a period when the tappers have not much work in the fields. In Bombay, the trees are also tapped in November and December. The yield of sweet toddy is higher during cold months than in summer.

Generally, mature trees, 25-30 years old, are selected for tapping, and the trees go on yielding for some 30 years. In some areas, where the soil is porous and sandy, tapping may commence at the 15th year. The trees are usually given rest once in 3 years. The daily yield of sap from a tree is on an average about 0·5 gal., and the total yield per season is usually about 40 gals. Much higher yields (over a gal. or 12·5 lb.) per day have been reported from Bihar (Sethi and Ghosh, *loc. cit.*).

Trees of both sexes are tapped. In the case of male trees, the flowering shoots, which look like finger growths on the principal stalk, are bruised by rubbing them between wooden sticks. After a couple of days, these are scraped with a tapping knife and their tips are pared off daily. The juice begins to ooze out within a week after bruising, when several fingers are tied together and bent into a pot. The inflorescences of female trees are tapped when the nuts are still very small, and only the tips are squeezed and beaten. They are then pared off as in the case of male trees. A male tree is reported to yield only 2/3 the quantity given by a female tree. It is commonly believed that the sap from the male tree contains a higher proportion of sugar. This, however, does not appear to be generally true (cf. Joachim and Kandiah, *loc. cit.*; and Ghose, *Agric. J. India*, 1920, **15**, 32).

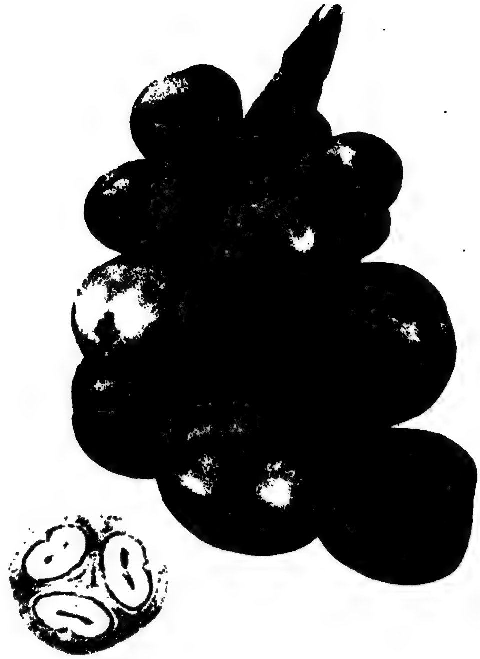
The tappers climb twice a day, once in the morning and once in the evening. In the morning, the tapper gets up with his spare pot for bringing down sweet toddy. After he empties the juice into the collecting pot, he dresses the cut by paring off a slice, limes the pot and replaces it. In the evening, the juice is not lowered since the quantity collected during the day is small, but the cut is dressed and the pot is given a shake. Tapping is a skilful operation and a good tapper can look after 20–25 trees, working for 4 hours in the morning and 2 hours in the evening. In some parts of India as in Bihar, and in Ceylon, the pots for the collection of sweet toddy are thoroughly cleaned, heated and smoked inside, and used, with or without liming.

Smoking the pots has been found to delay inversion of sucrose, although not so well as coating them with lime. The amount of invert sugar in the juice collected in smoked pots at night was found to be generally in the neighbourhood of 0·5–0·6 g./100 c.c. and sometimes even lower. The juice in limed pots contained as little as 0·05 0·06 g. of invert sugar per 100 c.c. According to Mitra and Mittra (*Indian J. agric. Sci.*, 1940, **10**, 824), although formalin is quite effective, lime is the best and cheapest preservative for sweet toddy. It is best put inside the pot as a thin coating which remains moist till the juice begins to trickle into it, and the effective dose is 0·25 g./200 c.c. or about 1/5 oz. per gal. of sap. Both inversion and fermentation stop completely when pH reaches 8·0 or 8·1.

PALM JAGGERY

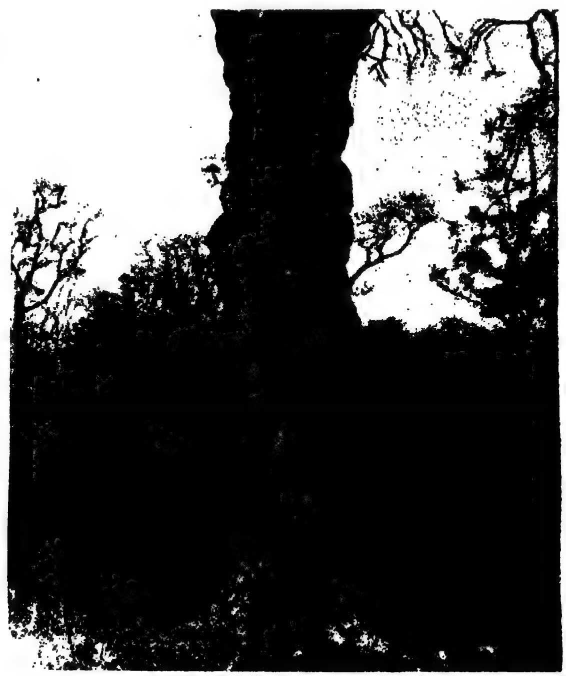
The boiling of juice begins immediately after it is lowered from the tree. In some parts, concentra-

1. BORASSUS FLABELLIFER



2 BUNCH OF BORASSUS FRUITS WITH INSET OF A CROSS-SECTION OF FRUIT

3. BOSWELLIA SERRATA



4 BROUSSONETIA PAPYRIFERA

tion is carried out at one stretch, while in others the juice is first evaporated to 1/3 the bulk, and the comparatively thicker saccharine solution is allowed to accumulate into a fairly large quantity, before being boiled down to *gur*. Sethi and Ghosh (*loc. cit.*) have shown that sucrose in the juice suffers very little inversion during its concentration.

After the juice is brought down, it is strained into the boiling pot, leaving behind the sediment of lime. Some 15–20 minutes after the commencement of boiling, a white scum rises to the surface which is skimmed off and a few castor beans are crushed and put in, to allay frothing. In the West Godavari dist. a little coconut oil is used instead. After about 2 hours, the fire in the oven is lowered, the contents of the pot stirred, and a small quantity of syrup poured into cold water. If it hardens quickly, it is ready for being transferred into wooden moulds, which are slightly moistened on the surface. *Gur* sets in about 15–20 minutes, and amounts to 15–18% of the sap.

The palmyra *gur*, thus prepared, is a dark solid with a characteristic flavour. Sometimes it is also treacly, especially if sugar has suffered inversion. It comes into the market in flat rectangular pieces, tied up in mats, made of palmyra leaves. It absorbs moisture, and in wet weather, it becomes a semi-solid sticky mass. This is due to the presence of deliquescent salts in it. If lime is precipitated by passing in a slow current of carbon dioxide before boiling the juice, the *gur* obtained is remarkable for its lightness of colour and flavour. Sethi and Ghosh (*loc. cit.*) suggest the use of citric acid, or an extract of unripe tamarind fruits to precipitate lime and to improve the quality of *gur*.

Sometimes brown sugar-candy is also prepared from palmyra juice. Raw juice is boiled down as before, but not to such a high degree of concentration as in the preparation of *gur*. The syrup is then poured into covered pots, and buried underground for some months, when crystals of sugar candy are deposited in the pots. This is considered a delicacy and is known as *tal misri*. It is also reputed to possess medicinal properties and is used in coughs and pulmonary affections, and as a laxative for children.

Almost the whole of palm *gur* produced in the West Godavari dist. finds its way into the refinery at Samalkot, owned by Messrs. Parry & Co. During '27–31, the factory handled on an average 8,093 tons of palm *gur* per annum. Their factory at Nellikuppam also handled a similar quantity of palmyra *gur* produced in the southern districts of Madras.

The following are the analyses of representative samples of *gur* used for refining :

	I	II
	(Per cent.)	
Sucrose . . .	80·00	76·70
Glucose (invert sugar)	2·00	3·37
Ash, soluble . .	3·48	3·56
Moisture . .	9·05	9·25
Undetermined . .	5·47	7·12
Refining value .	60·60	55·53

The refining value is obtained by the following empirical formula : percentage of sucrose – (percentage of soluble ash × 5 + percentage of glucose), and is nearly equal to the actual percentage of crystalline sugar recovered after refining.

In the factories, raw *gur* is heaped on platforms for about 2 months to drain away most of the molasses, then dissolved in water, and refined in the usual manner to crystalline sugar. The molasses obtained during crystallization are used for producing arrack.

THE FRUIT

When the fruits are tender, the seeds consist of a soft, sweet, gelatinous pulp with a little liquid in them. These are much relished in summer. The pulp gradually hardens into a bony kernel, and develops a fibrous coat. The cotyledon, in germinating seeds, a cream-coloured substance of the consistency of cheese, is sweet, and pleasant to taste. When seedlings are 2–3 months old, the tender shoots, which are starchy, are edible and sometimes flour is made from them. It is reported that the young fleshy roots, about 4 months old, also contain starch and are eaten (Burkill, I, 352). In Ceylon, the soft, yellow, pulpy tissue, under the outer skin of ripe fruits, is squeezed out and the juice is dried in thick layers into an edible preparation called *punatoo* (Blatter, 181). In Bengal this juice is consumed as such, or is made into sweets.

COMPOSITION OF SOME OF THE EDIBLE PRODUCTS FROM THE PALMYRA PALM §
(Per cent.)

	Moisture	Protein	Fat	Mineral matter	Carbo-hydrates	Total sugar	Disaccha-rides	Reducing sugars	Vitamin C mg./100g.
Nira	85·94	0·23	0·02	0·29	13·52	12·6	11·6	0·4	5·7*
Tar *gur*	8·61	1·73	0·08	1·81	88·47	84·0	79·9	2·0	..
Tender seed pulp. .	92·60	0·64	0·10	0·26	6·29	..	..	..	13·1
Cotyledon . . .	80·99	0·75	0·12	0·85	17·29	..	..	..	11·3
Pulp of ripe fruit .	77·22	0·67	0·15	0·68	21·28	..	..	..	24·0†
Flour (sun-dried). .	12·06	4·81	0·31	1·91	80·91	..	..	..	..

§ Mitra and Mittra, *loc. cit.*; * per 100 c.c. † also carotene, 7·6 mg. /100g.

THE FIBRE—BASSINE

The leaf stalks are highly fibrous and contain a large number of strong wiry fibres of considerable length, suitable for the preparation of brushes and brooms. Before the tapping season, it is usual to cut off all the older leaves (15–20) from the tree and to use leaf stalks for the preparation of fibre. Younger trees, 12–15′ high, yield a larger number of leaf stalks. For the extraction of fibre, the leaf stalk is torn apart into strips, after softening the ends by beating with a mallet. The fibres are then separated from the adhering soft tissue by combing the strips over a piece of wood to which a few nails are fixed. This fibre is known as bassine. The best quality of fibre is obtained from the margins of leaf stalks.

The extraction of palmyra fibre is a cottage industry. The fibre is prepared in considerable quantities in Krishna, Godavari and Tinnevelly dists., the Palghat sub-division of Malabar, and in south Travancore. The produce is collected by factories which clean and grade the material, and cut it into lengths varying from 6–16″. It is then dyed purple, tied into neat bundles and pressed into bales. It is exported in two qualities, dressed fibre and graded fibre. The former consists of fibre cut into exact lengths, measured in inches and half inches, and the latter, produced by a similar but rougher method, is sorted into 3 lengths only.

According to Messrs. Aspinwall & Co., Colachel (Travancore), brooms and brushes prepared from palmyra fibre are not used to any large extent in India, and the consumption of the fibre in normal times is very small. But during the War ('39-45) nearly 9 lakhs of fibre brushes were prepared by them for the Supply Department.

AVERAGE ANNUAL EXPORTS OF FIBRES FOR BRUSHES AND BROOMS (CHIEFLY PALMYRA FIBRE)

		Qty. (Tons)	Val. (Lakhs of rupees)
In quinquennium ending	'33-34 . .	7,133	24·03
,,	'38-39 . .	8,106	19·39
,,	'43-44 . .	4,771	12·50
In	'44-45 . .	2,635	12·20

Palmyra fibre is exported mainly from the ports of Coconada, Calicut and Tuticorin. Before 1940, the principal buyers were the U.K., Germany, Japan, Belgium, the U.S.A. and the Netherlands. During the quinquennium ending in '44, the U.K. imported 35·3% of Indian exports, and the U.S.A., 40·3%.

The timber (average wt., 49–50 lb. per c.ft. Gamble, 738) is able to bear a considerable amount of cross-strain, and long pieces of varying width cut from the stem are extensively used in hut construction for rafters, pillars, and posts, and for crude bridges. Longitudinally split stem halves, and even entire stem pieces, after removing the soft inner portion, are used as water channels.

In India, palm leaves were formerly used as writing material, using an iron style for a pen; cut into rectangular pieces, and punched and strung together they formed books. The leaves are extensively used for making fans, umbrellas, baskets and mats, and for thatching roofs. Brooms are made from their stiff veins.

The stem-fibres, without any spinning or twisting, are reported to be plaited into fish traps, after being made pliable. The tree yields a black gum.

BORAX

D. E. P., I, 504; C. P., 171.

SANS.—*Tan-kana*; ARAB.—*Burak-es-saghah, boraq*; PERS.—*Tankar*; HIND.—*Sohaga, tinkal*; BENG.—*Sohaga*; GUJ.—*Tankankhar*; TAM.—*Vengaram*; TEL.—*Elegaram*; KAN.—*Biligara*; MAL.—*Vellakaram.*

Borax occurs in the form of large transparent monoclinic prisms, often dulled on the surface (sp. gr., 1·69–1·72; H., 2–2·5). It is sparingly soluble in cold water, but is more soluble in hot water. Solubility at 10° is 3 g./100 g. and at 100°, 99·3 g./100 g. Its aqueous solutions show an alkaline reaction. When heated, it gradually loses its water of crystalliszation, swells up and finally becomes a fused glassy mass. It lessens the coefficient of expansion of glass.

Borax has excellent fluxing properties and is used in several smelting, soldering and welding operations. As a scouring agent, it is employed in the casting of different types of bronze. It is extensively used in the manufacture of glass and enamels, and in the glazing of pottery and chinaware. Owing to its mild antiseptic properties, borax is used in the manufacture of soaps, cosmetics and lotions, and in food preservation. Borax is employed to give glaze to certain kinds of paper and playing cards. It is used in curing hides and skins; in finishing leather; in paints and varnishes; and in the textile industry, as a solvent bleach, detergent and fire-proofing material.

Borax occurs in the Puga valley (15,000′ above sea level), which extends from Rupshu dist. in eastern Kashmir into Hundes in south-western Tibet. It is associated with salt and sulphur, emanating from hot springs, and is produced in the Hundes region, by lixiviating the soil from dried lake beds (Coggin Brown, 246). It is reported that in 1942, 551 tons of borax valued at Rs. 30,000 were produced in Puga dist.

The bitterns from Sambhar lake of Rajputana contain about 0·5% of borax. In Kathiawar, borax is reported to have been extracted from the soil around Limbdi (22°34′ : 71°52′).

The U.S.A. is the largest producer of crude borates and borax materials, with a production in 1940 of 243,355 short tons of crude borates, valued at $ 5,645,390. Argentina, Italy and Turkey also enter the international market, but their production is very small. Imports into India were chiefly from the U.K., the U.S.A. and Japan. Tibetan borax, *tinkal*, imported into India, is obtained from a series of saline lakes and dried lake beds between the Ladakh region and Tibet.

AVERAGE ANNUAL IMPORTS OF BORAX INTO BRITISH INDIA

		Qty. (Cwt.)	Val (Rs.)
In the quinquennium ending	'33-34	20,370	2,21,767
"	'38-39	28,898	3,03,668
"	'43-44	32,259	7,42,588
In	'44-45	53,855	16,13,285
"	'45-46	28,583	6,70,577

Before 1942-43, there was a small export mainly to the Straits Settlements and Hongkong.

BORRERIA G.F.W. Mey. Syn. *Spermacoce* Linn.
RUBIACEAE

D. E. P., VI, iii, 320; Fl. Br. Ind., III, 200.

A genus consisting of 100 spp. of annual or perennial herbs, distributed in tropical countries. In India, it is represented by 3 or 4 spp. Several species are medicinal.

B. hispida (Linn.) K. Schum. (syn. *Spermacoce hispida* Linn.), is a procumbent herb distributed from the Himalayas at Simla, eastwards to Assam, and southwards to Ceylon. A decoction of its root is used as an alterative. Its seeds are reported to be used as a substitute for coffee (Kirt. & Basu, II, 1301), and the leaves are eaten in times of scarcity,

Bort, see **Diamonds**

BOSWELLIA Roxb. BURSERACEAE

A genus consisting of 10 species of trees and shrubs, distributed in the tropical parts of Asia and Africa. *B. carterii* Birdw. of Africa and Arabia yields frankincense (olibanum), an oleo-gum-resin imported into India. *B. serrata* is the only species found in India.

B. serrata Roxb. THE INDIAN OLIBANUM TREE

D. E. P., I, 511 ; Fl. Br. Ind., I, 528 ; Pls. XXXII, 3, & XXXV, 1.

SANS.—*Kunduru*, *sallaki* ; ARAB.—*Kundur* ; HIND., BENG. & MAR.—*Salai* ; TAM. & TEL.—*Parangisambrani* ; KAN. -*Madi* ; TRADE—*Salai*.

A moderate or large branching tree with a bole 12–15′ in height and 3–5′ in girth, generally found in dry hilly areas. It is common in most parts of the Central Provinces, the Deccan, Bihar, Orissa, Rajputana, Central India, Eastern States, and north Gujerat ; but not found in Bengal, Assam, and Burma. Two varieties are usually distinguished : var. *serrata* with serrate and pubescent leaves, and var. *glabra* with entire, glabrous leaves.

The tree, on tapping, exudes an oleo-gum-resin which is known as Indian olibanum. This is sometimes called *guggul*, a term which is also used for Indian bdellium obtained from *Commiphora mukul*, a member of the same family, Burseraceae. The fresh exudation of *B. serrata* resembles Canada balsam in colour and consistency. It hardens slowly, retaining its golden colour and transparency. The odour is that of olibanum, but fainter and more terebinthinate. It burns readily and diffuses an agreeable odour (Dymock, Warden & Hooper, I, 303).

The tapping of boswellia gum for industrial purposes has not met with much success, because of very variable yield. Generally trees over 30″ in girth, and also those damaged by borers yield the gum in some quantity, while some trees do not exude any. Dwarfed and suppressed trees, or very old trees give poor yield. Tapping does no injury to the tree and the method of tapping influences yield. One method, which is reported to have met with some success, consists in shaving off a thin band of bark (6″ in width), 2–2·5′ from the base of the tree and freshening it every 4th or 5th day. The gum exudes usually after the first freshening. Tapping period extends from November to June or July. Pearson & Puran Singh (*Indian For. Rec.*, 1919, **6**, vi) found the average annual yield of gum per tree to be about 2 lb., but according to Trotter (1940, 285), the over-all yield from large areas of forests is too small to be economical.

Indian olibanum has the following average composition : moisture, 10–11 ; volatile oil, 8-9 ; rosin 55-57 ; gum, 20-23 ; insoluble matter, 4-5% (*Bull. imp. Inst., Lond.*, 1919, **17**, 159). It is chiefly used as incense. It is reported to be employed in Indian medicine for rheumatism and nervous diseases, and as an ingredient of certain ointments (Dymock, Warden & Hooper, *loc. cit.*).

For the separation of the oleo-gum-resin into its constituents, Pearson and Singh (*loc. cit.*) suggested the extraction of the residue left after steam distillation with solvents like petrol, benzene, etc. This method, although it gives cleaner products, is uneconomical on a large scale. According to Fowler and Malandkar (*J. Indian Inst. Sci.*, 1921, **4**, 27), after preliminary removal of the volatile oil by steam distillation (yield, 8%), the residue is heated with water (2·5 parts) under 30 lb. pressure for $1\frac{1}{2}$ hours in an autoclave. The resin melts, becomes mobile and separates completely as a molten mass at the top, and later solidifies on cooling (yield, 52–54% of gum-resin). The gum forms a flocculent precipitate or mucilage and settles at the bottom of the vessel. After removal of the supernatant aqueous layer, the mucilage is strained off and carefully evaporated to dryness. This yields the gum in the form of a dark mass, which on grinding becomes a grey powder (yield of dry gum, 23%).

VOLATILE OIL, ROSIN, AND GUM

The oil is usually pale yellow and has an agreeable odour. A sample examined by the Imperial Institute was found to have the following constants; sp. gr./15°, 0·8446 ; $[\alpha]_D$, +31°24′ ; ester val. before acetylation, 2·6 ; ester val. after acetylation, 36·4. On fractionation, 89% of this oil distilled over at 153–160°, and the rest between 160–180° and above. The constants show slight variations and depend upon the method of preparation of the oil, and the period it has been kept (*Bull. imp. Inst., Lond., loc. cit.*).

Simonsen (*Indian For. Rec.*, 1923, **9**, vi) found that when a sample of the oil was fractionated

at 200 mm. pressure, 60·4% distilled over between 112-120°, 24% between 120-140°, and 14% between 140-230°. The lower fractions consisted principally of d-α thujone with small quantities of α-pinene and d-α-phellandrene, and the higher fractions contained sesquiterpene alcohols, small quantities of anisaldehyde and phenolic components (Roberts, *J. Soc. chem. Ind., Lond.*, 1923, **42**, 486T).

Boswellia oil is very similar to turpentine oil. It readily dissolves colophony, dammar and other resins. Varnishes prepared from it are less lustrous, but quicker in drying, than those prepared from ordinary commercial turpentine. The inclusion of the higher boiling fractions does not appear to have any adverse effect on the quality of the varnishes, and it should be possible to prepare a product which agrees in range of boiling point with commercial American turpentine. In India, the oil has been found suitable for paint making, and paints prepared with it dry within 24 hours. With respect to volatility, it is better than turpentine oil from *Pinus longifolia* prepared in India (*Bull. imp. Inst., Lond.*, 1919, **17,** 159).

The rosin varies in colour from transparent golden brown to dark-brown or dark greenish-brown. It is very brittle, with a vitreous fracture, and resembles colophony in odour and is tasteless. It is soluble in most organic solvents, and does not dissolve completely in sodium carbonate solution even on prolonged boiling. Its softening point varies from 65-72°, and the m.p. from 73 78°. From the analyses of samples carried out at the Imperial Institute, the following is taken as typical: sp. gr. 20°/20°, 1·082 ; moisture, 0·7 ; ash, 0·5 ; sap. val., 92 ; acid val., 51·1. According to Fowler and Malandkar (*loc. cit.*) the iod. val. is 103-115.

The rosin has been found suitable for the preparation of varnishes. Varnishes prepared with 1 part of rosin and 1-2 parts of turpentine oil, or 1 part of alcohol, when applied to sized wood, dry slowly to a clear bright hard coat. Since it contains a smaller proportion of rosin acid it cannot be used for making rosin soaps or rosin sizes. (*Bull. imp. Inst., Lond., loc. cit.*).

Hydrolysis of the pure gum of *B. serrata* yields mainly pentoses (65% as arabinose) with a high proportion of arabinose. Galactose and xylose are present only in small quantities (Malandkar, *J. Indian Inst. Sci.*, 1925, **8A**, 240). The gum also contains oxidizing and diastatic enzymes, and 3·03% of total nitrogen (Fowler and Malandkar, *ib.*, 221).

Commercial samples of gum contain varying proportions of resin and about 50% of water soluble material. They form non-homogeneous pasty masses with water, and are not suited to sizing and finishing textiles. Even the best sample (water soluble matter, 73·7%) did not compare favourably with gum arabic. As a paper size, the high percentage of resin is likely to produce early yellowing and rapid deterioration in the case of white paper (*Bull. imp. Inst., Lond., loc. cit.*).

Although there are extensive areas under Boswellia and the gum-oleo-resin yields products, which are likely to be readily utilized in industries, so far its commercial exploitation has not been possible for lack of economic method of tapping and collection.

Formerly small quantities of the oleo-resin were exported. The average annual exports during the quinquennium ending '39-40 amounted to 171 cwt. valued at Rs. 5,301. Since 1940, there has been a marked rise in exports. In '43-44, the U.S.A. imported 2,403 cwt. out of a total export of 2,491 cwt. valued at Rs. 61,796.

TIMBER

B. serrata is also a timber tree. The timber consists principally of sapwood which is quite large and has an even, straight grain with a rough feel. It is moderately strong, but soft (air-dry wt., 36 lb. per c.ft.). It is easy to saw and work, but it is difficult to get a good surface, or to peel. Sapwood is not prone to splitting or cracking and is readily kiln-seasoned without degrade. It is liable to attack by fungi and insects, and is useless unless properly seasoned and treated. Fungal attack not only produces discolouration, but also results in rapid decay of wood. Logs must be cut during dry season because of the increased liability to fungal attack in damp months. Air seasoning is not suitable for *salai*. The drying process must be rapid, and should be followed by treatment with preservatives. The heartwood is usually not large enough for practical use, and is highly refractory. Before seasoning it must be separated from sapwood (Trotter, 1944, 62).

Salai is used for inferior planking, cheap furniture, cooperage, cheap box-work and packing cases. It has been used for match splints, but its liability to fungal attacks is a serious disadvantage. It is also suitable for certain types of cheap paper. During the last War ('39-45) it was extensively used for ammunition boxes. Ammunition boxes made of *salai* were even stronger than those prepared from teak (Trotter, 1944, *loc. cit.*). In the C.P. attempts are being made to utilize the wood for the preparation of mechanical pulp for newsprint.

The wood may also be used for second-grade plywood (Kapoor and Datta, *J. sci. industr. Res.*, 1944, **3**, 167). It is not suitable for pencil manufacture (Rahman and Ishaq, *Indian For. Leafl.*, No. 66, 1945) or for sleepers. It is also not a good fuel wood. Small pieces burn quickly while large pieces burn slowly but with much smoke.

B. serrata forms almost pure forests in many places and supplies are abundant. The aggregate possible supply from the Central Provinces, Madras, Bombay, Bihar, Orissa, and the Jhansi division of the U.P. runs up to 1,00,000 tons per annum (Pearson and Brown, I, 217). The price in 1937 ranged between Rs. 19 and Rs. 40 per ton (Trotter, *loc. cit.*).

BOTHRIOCHLOA Kuntze GRAMINEAE

A small genus of perennial grasses, found in Tropical Asia, Africa and Australia. *B. intermedia*, and *B. pertusa*, found throughout India, are fodder grasses.

B. nitermedia R. Br. A. Camus Syn. *Andropogon intermedius* R. Br.

Fl. Br. Ind., VII, 175.

HIND.—*Sandhor* ; BENG.—*Sudugan* ; C.P.—*Khar, jhara.*

A tall grass upto about 6–7′ high, found throughout India. It can be readily raised from cuttings, and has a rapid growth. When not too old, cattle eat it readily. The annual yield of dry grass per acre is 2 tons (Hole, *Indian For. Rec.*, 1913, **5**, iii, 18).

This grass yields a good clean pulp and is not objectionable when found in admixture with paper-pulp yielding grasses. (Raitt, *ib.*, 38). The grass yields 0·03% volatile oil (Wehmer, I, 113).

B. pertusa Willd. A. Camus Syn. *Andropogon pertusus* Willd. THE SOUR GRASS, THE PITTED BLUE GRASS

D. E. P., I, 249 ; Fl. Br. Ind., VII, 173.

PUNJ.—*Palwan* ; HIND.—*Sandhur* ; MAR.—*Gohhaya* ; TEL.—*Janu gaddi, turri gadai* ; TAM.—*Chinna-karai pullu.*

A perennial grass, seldom reaching more than a foot in height. The purplish inflorescence when crushed between fingers emits an aromatic odour (*J. Bombay nat. Hist. Soc.*, 1891, **6**, 67). It is found throughout India, especially in the U.P. When cultivated it grows much taller than when wild and produces luxuriant foliage.

It is much valued as a good fodder grass, both for grazing and for stacking. It grows quickly and stands cutting, and has been recommended for grazing mixtures. It gives a large yield of hay (approx. 60% by wt. of fresh grass, *Kew Bull.*, 1896, 115). When grazed or mown, it sends out numerous creeping shoots rooting at the nodes. Hence it is a satisfactory grass for lawns.

The grass (moisture-free) contains: ash, 10·4 ; crude protein, 8·8 ; fibre, 33·0 ; N-free extract, 46·1 ; and fat, 1·7% (Sen, *Imp. Coun. Agric. Res., Misc. Bull.* No. 25, 1945, 12).

BOTRYCHIUM Sw. OPHIOGLOSSACEAE

D. E. P., I, 517.

A cosmopolitan genus of ferns, comprising about 40 spp. *B. lunaria* Sw., *B. ternatum* Sw., *B. virginianum* Sw., occur in India at 5,000–13,000′ from Kashmir to Sikkim. They are reported to be medicinal, being used in dysentery, ruptures and for healing cuts and wounds (Caius, *J. Bombay nat. Hist. Soc.*, 1935, **38**, 352).

BOUCEROSIA Wight & Arn. ASCLEPIADACEAE

D. E. P., I, 517 ; Fl. Br. Ind., IV, 77.

This genus includes 30 species of leafless fleshy herbs, distributed in tropical Africa and Asia. 6 species are found in India.

B. aucheriana Decne. is a succulent herb 2–6″ high, common in the dry hills of western Punjab.

The fleshy stems are eaten both raw and cooked. They are reported to be stomachic, carminative and tonic, and useful in rheumatism (Kirt. & Basu, III, 1640).

BOUEA Meissn. ANACARDIACEAE

The genus includes 4 Indo-Malayan species of fruit trees, 3 of which have been introduced into India.

B. burmanica Griff.

D. E. P., I, 518; Fl. Br. Ind., II, 21.

BENG.—*Miriam, uriam.*

A handsome, medium-sized tree, found in the Andamans and Tennasserim and cultivated in the moister parts of Burma. The fruit is a yellow fleshy drupe, 1–2″ long, with sweet acid pulp and a single seeded stone. It tastes like mango, but the flavour is somewhat inferior.

The wood is grey, hard, with a dark reddish-brown heartwood (air-dry wt., 55 lb. per c. ft.). It is said to be durable, and is used in the Sundarbans for parts of boats above the water-line (Gamble, 214).

The tree sometimes yields gum (Burkill, I, 355).

BOUSSINGAULTIA H. B. & K. BASELLACEAE

A genus of 10 species of herbaceous creepers with underground tubers, indigenous to tropical America.

B. baselloides H. B. & K., an ornamental climber with white fragrant flowers, is often cultivated in south India and Bombay. Its leaves are sometimes used as spinach, and its tubers are edible. The latter are rich in starch and mucilage. The fresh tubers contain: moisture, 85; N-free extract, 10·5; N-substances, 2·3; fat, 0·27; crude fibre, 0·4; and ash, 1·35%. The dry material gives: N-free extract, 70·7; and N-substances, 15·4% (Wehmer, I, 302).

Box myrtle, see **Myrica nagi**

Box-wood, see **Buxus wallichiana**

BRACHIARIA Griseb. GRAMINEAE

A large genus, formerly regarded as a section of *Panicum*, consisting of about 100 species of annual or perennial grasses, distributed in tropical and sub-tropical regions. About 15 species are found in India. A number of species, e.g. *B. distachya* Stapf, *B. eruciformis* Griseb., *B. mutica*, *B. paspaloides*, *B. ramosa* and *B. setigera* (Retz.) C. E. Hubbard, are fodder grasses.

B. mutica Stapf Syn. *Panicum muticum* Forsk.
PARA GRASS, MAURITIUS GRASS, BUFFALO GRASS

Fl. Br. Ind., VII, 34; Fl. Assam, V, 272.

BENG.—*Nardul.*

A coarse-looking, perennial grass spreading rapidly by surface runners, which root copiously at the nodes, and also bear erect leafy culms 6′ or more in height. It is indigenous to South America and West Africa, but has now been introduced into every warm country of the world. It flourishes in any soil, but prefers damp and almost water-logged situations, like the edges of ponds and tanks.

Para grass was tried at Poona in 1894 and grew well at the Government Experimental Farm, yielding 13·5 tons of green fodder per acre (Mann, *Dep. Agric., Bombay, Bull.* No. 100, 1921, 111). Very high yields have been reported from Malaya (35 tons per acre) and from British Guiana (41·5 tons per acre) (Burkill, I, 357). It is a pasture grass and is fed green.

B. paspaloides (Presl.) C. E. Hubbard Syn. *Panicum ambiguum* Trin. CRAB GRASS

D. E. P., VI, i, 15; Fl. Br. Ind., VII, 33.

HIND. & PUNJ. *Takri, takria*; MAR.—*Karkol-jodi, chikhari.*

An annual grass 2–4′ in height, appearing in plains and at low elevations on the hills, in early monsoon. It is a common grass in India and extends to Burma and Ceylon. It grows both on heavy and light soils.

It is a good fodder grass both when green and when dry. The yield has been estimated at 2 tons of first quality hay per acre (Duthie, 12). It is also reported to be a good grass for turfs (Ridley, *Kew Bull.*, 1894, 386).

The mature grass contains: moisture, 69·1; fat, 2; albuminoids, 1·1; carbohydrates, 13·7; fibre, 10·2 and ash, 4%. The grass is soft and is relished by cattle. It has been found to increase the flow

of milk (Burns, *Dep. Agric., Bombay, Bull.* No. 78, 1916, 14).

B. ramosa Stapf Syn. *Panicum ramosum* Linn. Fl. Br. Ind., VII, 36.

TEL.—*Anda korra*; TAM.—*Pala pul*; KAN.—*Bennakki hullu*; MAL.—*Chama potharal.*

An erect or sub-erect, annual or perennial grass, 2–3′ high, found throughout the plains of India, particularly on cultivated lands. It is cultivated in some parts of Madras and Mysore for its grain (Jacob, *Madras agric. J.*, 1943, **31**, 12). The grain is considered superior to that of *Panicum miliare*, and the flour is usually mixed with that of *ragi* (*Eleusine coracana*).

B. ramosa is cultivated as a short duration crop, sown between the middle of Aug. and middle of Oct. and harvested by the end of December. It yields about 300–500 lb. of grain and 500 lb. of straw per acre. The straw is relished by cattle.

Bracken or **Brake,** see **Pteris**

BRAGANTIA Lour. ARISTOLOCHIACEAE

A genus of 5 species of shrubs and undershrubs, distributed in India and Malaya. 4 of these are found in India. *B. tomentosa* Blume (=*Apama tomentosa* Engl.) and *B. wallichii* are medicinal.

B. wallichii R. Br.=*Apama siliquosa* Lam.

D. E. P., I, 519; Fl. Br. Ind., V, 73.

SANS. & MAR.—*Chakrani*; KAN.—*Nirurate*; MAL.—*Alpam.*

An erect shrub of the Deccan peninsula and Ceylon; it is common in the evergreen forests around Gersoppa falls and in south Konkan.

The mature roots are used by the Ayurvedic physicians of Konkan, and the Malnad districts of Mysore, for the treatment of dysentery. They are ground to a paste with lemon juice (60 gr. in ½ oz.) and administered orally every 15 minutes.

The roots are said to be efficacious in cholera. It is also claimed that an ointment prepared from the plant is beneficial in the treatment of carbuncles and inveterate ulcers.

The roots contain isoaristolochic acid, $C_{17}H_{11}O_7N$, which was first isolated from *Aristolochia indica* (Manjunath & Shankara Rao, *J. Indian chem. Soc.*, 1938, **15**, 646). Qualitative tests indicated the presence of alkaloids, but no pure base could be isolated.

BRASSICA Linn. CRUCIFERAE

The genus *Brassica* consists of over 150 species of annual or biennial herbs, several of which are cultivated as oil-seed crops (rape and mustard) or as vegetable crops (cabbage, cauliflower). The seeds of some yield the condiment, mustard. A few brassicas furnish fodder and green manure.

These plants are natives of the north temperate zone, but pass into the sub-tropics and tropics as cold weather crops. There appear to be three great centres of origin: Europe, central and southern Asia, and China. Recent studies of Russian botanists have shown that eastern Afghanistan, together with the adjoining portion of north-western India, is one of the independent centres of origin of plants of the *B. campestris* group. Plants belonging to the species *B. juncea* found their way into India from China through a north-eastern route and their migration was independent of any Aryan incursion (Prain, *Agric. Ledger*, 1898, **5**, 10). The cabbage, the cauliflower, etc., are derived from *B. oleracea* of European origin.

The vegetables, cabbage, cauliflower, brussels sprouts, knol-kohl are varieties of *B. oleracea*, and turnip is *B. rapa*. In India, the oleiferous brassicas, *B. juncea* var. *rugosa* (*Pahari rai*), *B. juncea* var. *cuneifolia* (*Lai*), and *B. napus* are grown as vegetable crops.

OLEIFEROUS BRASSICAS

The oil-yielding brassicas which are predominantly cross-pollinated, constitute a group, about which considerable confusion exists regarding their identification and nomenclature. Those extensively cultivated for the production of rape oil are: *B. napus* and *B. juncea* in China and Japan; *B. napus* and *B. praecox* Waldst. & Kit. in Europe and America; and *B. juncea* and probably *B. napus* in Russia and in the Mediterranean areas.

Zafar Alam (*Indian J. agric. Sci.*, 1945, **15**, 173) has discussed the problem of the nomenclature of Indian oleiferous brassicas grown in the Punjab, and Prain (*loc. cit.*, 55), of those grown in eastern India. In India the principal oil-seed crops are yellow *sarson*, brown *sarson*, *toria* and *rai*. Punjab *rai* is grown to a limited extent in the central

1. SARSON
(BRASSICA CAMPESTRIS VAR. SARSON)

2. TORIA
(BRASSICA CAMPESTRIS VAR. TORIA)

3. RAI
(BRASSICA JUNCEA)

4. BENARASI RAI
(BRASSICA NIGRA)

districts of the Punjab. *Benarasi rai* and white mustard are also grown to a small extent. The seeds of these two species are used for the preparation of table mustard.

Taramira (*Eruca sativa*), an oil-seed crop (oil content, 30–35%) largely grown in Sind and the Punjab, yields an oil (*Jamba* oil) which closely resembles Indian rape oil (*vide infra*), and is used for similar purposes.

world as oil-seed crops. Although several of these are distinct species or varieties, they all yield oils with similar constants and composition, known as rape oil—sometimes also called colza oil. But the latter term is now generally applied only to refined rape oil (Jamieson, 227). A variety of *B. campestris* cultivated in the Black Sea region yields Ravison oil, which is generally used for technical purposes. In Europe, the oil pressed from mustard seeds (*B. nigra* and *B. alba*) is called mustard seed oil.

TABLE 1

NOMENCLATURE OF INDIAN OLEIFEROUS BRASSICAS

Common name	Species	Chromosome No. 2n	Distribution	Fixed oil %	Volatile oil %
1. Yellow *sarson*, Indian colza.	*B. campestris* Linn. var. *sarson* Prain.	20	U.P., Punjab, Bihar and Bengal	35–48	0·27
2. Brown *sarson*	*B. campestris* Linn. var. *dichotoma* Watt.	20	Punjab	35–48	0·35
3. *Toria*, Indian rape	*B. campestris* Linn. var. *toria* Duthie & Fuller.	20	Punjab, U. P., Bengal and Assam.	33–46	0·14
4. *Rai*, Indian mustard	*B. juncea* Coss.	36	Bihar, Bengal and U. P.	30–38	0·45
5. Punjab *rai*	*B. tournefortii* Gouan	20	Central districts of the Punjab.	31*	..
6. *Benarsi rai*, True mustard.	*B. nigra* Koch	16	U. P., Punjab, Madras and N.W.F.P.	33*	0·68
7. White mustard	*B. alba* Boiss.	24	Upper India		

*From the Indian agric. Res. Inst.; other percentages, from Athawale, Duke and Mathur, *Bull. Indian Industr. Res.*, No. 13, 1938.

The seeds of oleiferous brassicas contain 35–50% of fatty oil and about 20% of protein matter. Their free essential oil content is usually very low, but they contain small proportions of glucosides which on hydrolysis yield volatile mustard oils. The fatty oils from the different varieties of brassicas closely resemble one another and are characterised by a high proportion of erucic acid, $C_{22}H_{42}O_2$ (45–50% of total fatty acids). Oleic and linoleic acids average about 47%, the former varying from 20–30% and the latter from 15–25%. The saturated acids, palmitic, stearic and lignoceric, are present in very small proportions. There is no evidence for the occurrence of rapic acid of earlier workers (Hilditch, Riley and Vidyarthi, *J. Soc. chem. Ind., Lond.*, 1927, **46**, 457T & 462T). The component glycerides consist of over 45% each, of di-'oleo'-erucins and 'oleo'-dierucin (C_{18} acyl group being either oleic or linoleic), with small proportions of monosaturated 'oleo'-erucins (Hilditch, 164).

Rape is a general term applied to seeds of oleiferous brassicas, cultivated in many parts of the

In India, the edible oil derived from cultivated brassicas (HIND.—*Sarson ka tel*; *kadua tel*) is called mustard oil, a term which, in Europe and America, is applied to the volatile oil of mustard seeds. Indian mustard oil is generally obtained from the seeds of yellow and black *sarson, toria*, and *rai*. The seeds that come to the market, however, are never pure, but consist of mixtures of these in widely varying proportions. This is due to their close resemblance to one another and to the practice of mixed cultivation. Even the seeds used for sowing often consist of mixtures.

Sudborough, Watson and Ayyar (*J. Indian Inst. Sci.*, 1926, **9A**, 25) have examined the fatty oils from *B. campestris* var. *napus* Linn. (*sarson*) and *B. juncea* DC. (*rai*). The former presumably refers to *B. campestris* Linn. var. *sarson* and the latter to *B. nigra* Koch. Athawale *et al.* (*loc. cit.*) have studied the oil of *B. campestris* (yellow and brown *sarson*), *B. juncea* (*rai*), and *B. napus* (*toria*). According to present nomenclature, the last species is *B. campestris* var. *toria*. In order to avoid confusion, it

is essential that in future only oils from pure seeds of definitely identified species should be investigated.

Rape is sometimes cultivated as a fodder crop. In England it is mainly fed to lambs and sheep (*Bull. imp. Inst., Lond.*, 1915, **13**, 452; *vide* also *Bull. Minist. Agric., Lond.*, No. 124, 1945, 4).

Ali Mohammad and Sultan Ahmed (*Indian J. agric. Sci.*, 1945, **15**, 181) have noted the disinclination shown by cattle to feed on the green fodder of certain oleiferous brassicas, and mustard seed cakes. This is mainly due to the irritating effects of the volatile oil in them. From a detailed study of the essential oil content of seeds, and of the various parts of the plants belonging to different species, they recommend brown *sarson* as the best for fodder. *Rai* and *taramira* possess greater pungency than *sarson* and *toria*.

B. alba Boiss.=*B. hirta* Moench Syn. *B. alba* Hook. f. & Thoms. WHITE MUSTARD

D. E. P., I, 521; C. P., 176; Fl. Br. Ind., I, 157.

Indian names are derived from HIND.—*Sufed rai*, white mustard.

B. alba, a self-sterile species, easily recognized by its hairy stem devoid of any bloom. It has irregularly pinnate leaves, large yellow flowers, and spreading, few-seeded and hairy pods. These have long, empty, knife-like beaks. The seeds are large, white, and lightly pitted, and give considerable amount of mucilage with cold water.

B. alba is a native of southern Europe and western Asia. It is grown only as a garden crop, in temperate upper India, during winter. In India, it does not contribute to the supplies of mustard or mustard oil.

TABLE II

CHARACTERISTICS OF BRASSICA OILS AND *JAMBA* OIL

Name of oil	Sp. gr. (15·5°/15·5°)	n	Sap. val.	Iod. val.	Erucic acid
Yellow *sarson* (*a*)	0·914–0·916	1·4635–1·4654/40°	169–171	99–101	—
Brown *sarson* (*a*)	0·914–0·916	1·4640–1·4649/40°	173–175	100–103	—
Toria (*a*)	0·913–0·917	1·4639–1·4655/40°	172–174	101–103	—
Rai (*a*)	0·915–0·917	1·4650–1·4658/40°	170–176	106–114	—
Commercial Mustard oils (*a*)	0·912–0·917	1·4633–1·4670/40°	169–177	99–107	—
Rape (English) (*b*)	0·911–0·918*	1·475/20°	172–175	94–106	50(*d*)
Black mustard (Mysore) (*c*)	0·9178§	1·4736/20°	179·8	109·7	41·5
Black mustard (English) (*b*)	0·914–0·923*	1·467/15°	173–176	96–107	50(*d*)
White mustard (English) (*b*)	0·912–0·916*	1·475/15·5°	170–178	93–109	52·5(*d*)
Jamba (*a*)	0·916–0·917	1·4655–1·4659/40°	174–176	99–101	46·3(*c*)

* at 15°/15°; § at 15·5°; (*a*) Athawale, Duke and Mathur, *loc. cit.*; (*b*) Hilditch, 119; (*c*) Sudborough *et al.*, *loc. cit.*, 43 and 52; (*d*) Hilditch, Riley & Vidyarthi, *loc. cit.*, 462T.

The seeds contain: moisture, 7·2; protein, 27·6; crude fat, 29·7; N-free extract, 20·8; fibre, 10·3; and ash, 4·5% (Wehmer, I, 409). For constants of the fatty oil *vide* Table II.

The seeds contain the glucoside, sinalbin, and the enzyme, myrosin. In the presence of water, the latter hydrolyses the former, producing acrinyl isothiocyanate, which is only slightly volatile, sinapine acid sulphate, and dextrose. The yield of volatile oil is low, 0·16% (Finnemore, 339).

The seeds of *B. alba* are rarely used alone, but they are mixed with black mustard in the preparation of mustard. They are not much used for the extraction of oil. In Europe, the oil-cake is used for fattening sheep. Young leaves and tender shoots are used as pot-herb. The species is sometimes cultivated for green manure.

B. campestris Linn.

An oleiferous species, with broad-based stem-clasping leaves, which are somewhat hairy and glaucous. In India, it is represented by the varieties *sarson* and *toria*.

Var. **dichotoma** Watt Syn. *B. campestris* var. *dichotoma* sp. Roxb. BROWN SARSON

D.E.P., I, 523.

HIND.—*Kali sarson*.

This variety has many characters in common with *toria* and resembles it more than it does yellow *sarson*. It is similar to *toria* in its open habit of growth, and flower and pod characters. It has a somewhat compressed stem with a rosette of large, bristly and hairy leaves. In these respects, it differs both from *toria* and *sarson*. It matures slightly later than *toria*. The seed coat has a mucilaginous epidermis. The species is highly self-sterile.

The plants resemble some of the Afghan plants of the *campestris* group. It is likely that this variety was introduced from the north-west into the Punjab from where it has extended eastwards.

Brown *sarson* is grown all over the Punjab, but is rarely found in other provinces. It is mostly grown as a mixed crop in the *barani* (rain-fed) areas. It has a slightly lower oil content than var. *sarson* (*vide* Table II).

Var. **sarson** Prain Syn. *B. campestris* var. *glauca* sp. Roxb. YELLOW SARSON OR INDIAN COLZA

D.E.P., I, 524; C.P., 176; Fl. Br. Ind., I, 156; Pl. XXXII, 1.

HIND.—*Sarson*; BENG.—*Sarisa*.

A sparsely branched herb with lower leaves and lower part of stem generally hairy. The petals are narrow and do not overlap as in *toria*. The pods are plumpy with a slightly flattened beak, often containing 1 or 2 seeds. These are light yellow or brown with a smooth seed coat and a non-mucilaginous epidermis. *Sarson* is a self-sterile species, and also matures later than *toria*.

Sarson is easily distinguished from *rai* by its stem-clasping leaves, and from *toria* by its rigid, compact, and tall habit. It has fewer branches, greater amount of bloom, and plumpy pods with stout beaks.

Sarson is an important oil seed crop in India and is more commonly grown in Bengal, Bihar, and the U. P. and it is also grown in the Punjab.

It is probable that this variety had its origin either in north-eastern India or China, where it exhibits a great diversity of forms. A number of forms, based on the colour of seeds (yellow or brown), the number of valves or chambers in the pods (2, 3 or 4), and the direction of ripe fruits in relation to the stalk (erect or pendent) are recognized, and some of these have been regarded as distinct species. Thus the 3-valved and 4-valved forms are known as *B. trilocularis* Hook. f. & Thoms. and *B. quadrivalvis* Hook. f. & Thoms., respectively.

The erect-fruited 2-valved forms are grown particularly in south Bihar, Chota Nagpur and western and eastern Bengal. They are not commonly met with north of the Ganges. Pendent-fruited, 2-valved forms are restricted to north Bengal. The 4-valved ones are generally grown north of the Ganges in Bengal, and south of the Ganges in Bihar. They are practically unknown in Chota Nagpur, Orissa and western Bengal.

Sarson requires a medium loamy soil. It is generally grown mixed with wheat or barley, and is sown in rows alternating with those of the cereals. It is therefore difficult to assess the exact acreage under this crop. Unlike *toria* which is usually grown under irrigated conditions, *sarson*

is mostly grown as a *barani* crop. It is generally sown in the beginning of October and harvested in the middle of February. Before sowing, land is prepared by ploughing it 2–3 times. To obtain good and uniform germination care must be taken to see that the seeds are not buried too deep in the soil, and it is better to use a seed-drill. The crop is seldom intercultivated. When sown as a mixed crop, the seed-rate is about 1·5–2·0 lb. per acre, and when sown as a pure crop, it is about 4–5 lb. per acre. It gives an average yield of 7 cwt. per acre.

Sarson is considered a rather precarious crop, susceptible to insect pests, blight diseases, and also to the vicissitudes of climatic conditions. It is often subject to attack by aphids, which suck the sap from young shoots and developing fruits. When aphid attack is very severe there is likelihood of total failure of crop. It is therefore generally grown in the Gangetic plain as a mixed crop.

The oil (*vide* Table II) is used in India for cooking purposes. It is also used for 'oil-baths' and it is believed to strengthen the skin and to keep it cool and healthy. With camphor it forms an efficacious embrocation in cases of muscular rheumatism, stiff neck, etc. The oil is used for lighting purposes, and the oilcake is a cattle feed. The seeds mixed with hot water form an efficient counter irritant poultice. The tender leaves and shoots are relished as pot-herb.

Var. **toria** Duthie & Fuller INDIAN RAPE

D.E.P., I, 525; C.P., 178; Pl. XXXIII, 2.

HIND.—*Toria*, *tori*.

In India, this species has often been referred to as *B. napus*. The plant has an open habit with a number of dichotomous branches and stem-clasping leaves. The petals are broader than in *sarson* and overlap each other along lateral margins. The anthers are extrorse. The pods are rather narrow and somewhat torulose.

This species is self-sterile. It is distinguished from *rai* by its smaller size, and stem-clasping leaves. It differs from yellow *sarson* in having smaller and bluish-brown seeds with a finely rugose surface, and a pale spot at the region of the hilum. The seed has narrow and distinctly circular markings on the testa, and is non-mucilaginous. The only other brassica having similar markings on the testa is *B. juncea* var. *rugosa*, which is easily diagnosed by its detachable epidermal layer.

Two forms are generally recognized: one, tall and late, and the other, dwarf and early. These are not taxonomically distinct and the characters vary according to environmental conditions.

In India, *toria* is an important oil-seed crop and it takes the place of *B. praecox* Waldst. & Kit. (Summer rape) and of *B. napus* of Europe. It is cultivated to a large extent in the Punjab and to a lesser extent in the U. P. It is generally grown under irrigation in canal colonies, but in certain parts, also as a *barani* crop.

The crop thrives best in medium or heavy loamy soils. It is generally sown by about the second week of September, presumably because it is liable to damage by cold and frost, and is harvested in January. It is the earliest of the Indian oleiferous brassicas and is therefore known as a *zaid kharif* or autumn crop. It requires a soil of good tilth and plenty of moisture. In the Punjab, it is generally grown as a pure crop.

The seed is sown by the broadcast method, but sowing by hand-drill is reported by Dep. Agric., Punjab to have given an average increase of 3 cwt. per acre. The seeds are not sown deep and the soil is lightly rolled over after sowing. The seed rate is 4–5 lb. per acre. A higher seed rate is given to promote leafy growth when the crop is intended for use as vegetable. The average yield of seeds is about 7-11 cwt. per acre.

The plants are very sensitive to drought during pod formation. It affects yield, and also makes the plants more susceptible to damage by frost. In irrigated areas the crop is watered twice, once at the seedling stage, and again when flowering has proceeded halfway through. The crop is not generally manured, but when it is grown in rotation with wheat, it benefits appreciably from the residual effects of green manuring by *guaar* (*Cyamopsis psoralioides*) of the previous wheat crop. Dep. Agric., Punjab has found that 40 lb. of nitrogen (ammonium sulphate) per acre increases the yield from 700 lb. per acre to 1,026 lb. (Burns, 73).

Toria is highly self-sterile and is consequently cross-pollinated. Selfing results in considerable deterioration in the vigour of plants. Methods like

mass selection and group breeding, through crossing with *taramira*, have been applied to the crop, resulting in high yielding selections like '*toria* selection A' of the Punjab. This selection gives a higher yield of seeds, 80–160 lb. more per acre, containing 45% of oil (2–3% more).

Ali Mohammad and Sikka (*Indian J. agric. Sci.*, 1942, 4, 11, 589) have used hive-bred bees for group breeding of the crop to evolve superior types. They have shown that under natural conditions the number of insects necessary for cross pollination of *toria* are below the needs of the crop, and that the yield could be greatly increased by supplementing the insect population with hive-bred bees.

The fatty oil (*vide* Table 11) is used for edible purposes, and the oil-cake, as cattle feed and manure.

B. juncea Czern. & Coss. Syn. *B. juncea* Hook. f. & Thoms. INDIAN MUSTARD

D.E.P., I, 528; C.P., 180; Fl. Br. Ind., I, 157; Pl. XXXIII, 3.

HIND. & BENG.—*Rai*.

B. juncea is a self-fertile species, and is a very variable annual. Its narrow-based leaves are not stem-clasping like those of *toria* and *sarson*. *Rai* matures later than either *toria* or *sarson*. The seeds are rugose, reddish-brown, and generally smaller.

Recently Ramanujam and Srinivasachar (*Indian J. Genet. & Pt. Breed.*, 1946, **3**, 73) have obtained plants closely resembling *B. juncea* by crossing *B. campestris* and *B. nigra*.

There are two races of *rai*: a tall, late, and a short, early. The latter is again divided into rough-leaved and smooth-leaved types (*vide* Howard, Howard and Khan, *Mem. Dep. Agric. India, Bot.*, 1915, **7**, 256).

B. juncea is a common field crop of Bihar, the U.P. and Bengal and is met with in almost all the brassica areas of India. Its cultivation extends westwards to Egypt and Europe and eastwards to China. It is also cultivated in Afghanistan.

Rai is either sown alone, or with peas or barley. Land is prepared as in the case of *toria* or *sarson*, and *rai* is first sown at the rate of 3 lb. per acre, and later peas are sown on the same land. The pea plants use the *rai* plants as supports, and bear a greater number of pods than when sown alone. *Rai* also gives a good yield when sown as a pure crop (seed rate 4–6 lb. per acre). It is mostly grown as a rainfed crop and is generally not intercultivated. It gives a yield of about 11 cwt. per acre. The crop is hardy and appears to be less susceptible to insect pests and diseases than other Indian oleiferous brassicas.

By the application of the pure-line method of breeding, the Departments of Agriculture in the Punjab, the U.P. and Bengal have evolved superior strains suited to the respective provinces. 'R. T. 11' evolved by Dep. Agric., U.P., is claimed to be the most aphid-resistant. It has given an average yield of 12–16 cwt. with a maximum of 19·0 cwt. per acre. '*Raya* L. 8' evolved by Dep. Agric., Punjab, has been found to be the highest yielder when compared with the local strains, and is said to be popular, both in the irrigated and unirrigated tracts of that province. 'O.B. 1' evolved by the same department is very hardy and drought-resistant and has given an average yield of 11·3 cwt. per acre against 7·3 cwt. of local *sarson*. Among the types tested against *toria* in the early or *zaid kharif* sowings, '*Raya* L. 16' has given the best results. '*Raya* 5' a selection evolved by the Dep. Agric., Bengal is said to be the best yielder in that province.

The seeds contain: moisture, 6·2; fat, 35·5; nitrogenous substances, 24·6; N-free extract, 20·4; crude fibre, 8·0; and ash, 5·3% (Wehmer, I, 408). The oil content of the seeds is usually 30–38%. Certain forms cultivated in the U.P. and locally known as *lahi*, *laha*, and *lahta* have a higher oil content (42–43%). Commercial *rai* also contains some *sarson*. Some samples contain the seeds of var. *crispifolia* Bailey, which resemble those of var. *rugosa*.

Rai yields less fatty oil than either *toria* or *sarson*. The oil is much purer and clearer than rape oil and does not have the peculiar rancid smell of the latter (for constants of the oil, see Table 11). In Bengal it is much relished as cooking oil. In Russia, it is used in place of olive oil.

Rai is an efficient substitute for black mustard. The U.S.P. recognises this species also as mustard. 'Brown mustard' and the 'expressed oil of mustard, prepared from the seeds of *B. juncea* are included in the I.P.L. The former should contain not less than 0·6% of allyl isothiocyanate.

Widely varying figures have been given for the volatile oil content of *B. juncea* seeds (up to 2·9%, Wehmer, I, 409). The oil has the following characteristics: sp. gr., 0·995; n_D, 1·5185; $[\alpha]_D$, +0°12′. It is reported to contain allyl isothiocyanate and related compounds, among which crotonyl isothiocyanate has been identified (Parry, I, 495; *vide* also Finnemore, 339). The latter is also obtained from a few other brassicas.

Athawale *et al.* (*loc. cit.*) found only 0·45% of essential oil in genuine samples of Indian seeds. A re-examination of the volatile oil content of the seeds and of its constituents is necessary.

Var. **cuneifolia** Roxb. Syn. *B. rugosa* var. *cuneifolia* Prain MUSTARD VEGETABLE

C. P., 182.

ASSAM—*Lai*.

The young plant has a rosette of dark, bluish-green, wedge-shaped leaves, with broad midribs and stalks, and looks like cabbage. In other respects, it resembles *B. juncea*, and is also self-fertile.

This plant and *B. juncea* var. *rugosa* appear to be the only cabbage-like vegetables that existed in India prior to the introduction of cabbages and cauliflowers. Var. *cuneifolia* is cultivated in north Bengal and Assam. The young leaves and tender shoots are eaten as pot-herb.

Var. **rugosa** Roxb. Syn. *B. rugosa* Prain CABBAGE LEAVED MUSTARD

C.P., 182.

This variety possesses a short stalk till the time of flowering, when it suddenly shoots up into a tall plant. The permanent radical leaves form a loose cabbage-like head. In other characters, it resembles *rai* closely, and is also self-fertile. The seed-coat has distinct circular markings, almost as narrow and sharp as those of *toria*.

Var. *rugosa* is grown to a limited extent as a cold weather crop in western, central and eastern Himalayas; it has spread westwards to Kumaon and eastwards to Bhutan. It is common in Nepal and is said to have been originally received from Tibet. It is cultivated more as a vegetable than as an oil-seed crop. The leaves are dried in the sun, pickled and eaten.

B. napus Linn. Syn. *B. campestris* Linn. sub. sp. *napus* Linn.

D.E.P., I, 523.

B. napus is a distinct self-fertile species with 19 pairs of chromosomes. The plant is covered with more bloom than either *toria* or *sarson*, and the leaves are also thicker and bluish-green. The flowers are larger than those of *toria*. The pods are thin, long and torulose. In the early stages they spread out on the fruit axis, and ultimately droop down.

The plant referred to as Chittagong mustard by Prain (*loc. cit.*, 22) presumably belongs to this species.

B. napus is grown in Japan as an oil-seed crop. It was introduced into the Punjab in 1910. It is also found in the N.W.F.P., but it does not appear to be grown in the other important brassica-growing tracts of India. *B. napus* is very late in maturity and remains green till about the middle of April. Since it ripens when the season is too hot for proper development to proceed, the out-turn of seed is low. It is highly prized as a vegetable as it provides a sweet and delicious *sag* during winter and early summer. Also it provides fodder for cattle at a time of scarcity.

B. nigra Koch BLACK MUSTARD OR TRUE MUSTARD

D. E. P., I, 530; Fl. Br. Ind., I, 156; Pl. XXXIII, 4.

HIND.—*Benarasi rai*; MAR.—*Mohari*; TAM.—*Kadugu*; TEL.—*Avalu*; KAN.—*Sasive*.

This species is highly self-sterile and is quite distinct from other brassicas. The fruits at maturity are closely appressed to the inflorescence axis. The seed coat shows fine reticulations under a lens, and is mucilaginous. The outer epidermis is covered with a thin cuticle.

B. nigra has been cultivated in Europe since the 13th century and is now reported to be growing wild. It appears to have been introduced only comparatively recently into India and is a cold season crop, grown to a limited extent in the U.P., the Punjab, N.W.F.P. and Madras. It does not contribute to the supplies of mustard oil.

The seeds contain: moisture, 7·6; N-substances, 29·1; N-free extract, 19·2; ether extract, 28·2; crude fibre, 11; and ash, 5% (Wehmer, I, 405). The seeds yield 27–33% of fixed oil (*vide* Table II).

The volatile oil of mustard (sp. gr., 1·015–1·025; n, 1·5267–1·5281) is obtained in a yield of 0·7–1·2% after the hydrolysis of the glucoside, sinigrin, by the enzyme, myrosin (Indian seeds are reported to yield 0·68%). The oil is optically inactive and consists almost entirely of allyl isothiocyanate (93–98%; Finnemore, 337; Parry, I, 495). Specifications for the pharmaceutical oil are (B.P.C.): sp. gr., 1·014–1·025; n/20°, 1·525–1·530; and allyl isothiocyanate content, not less than 92%.

For the preparation of volatile oil, the fixed oil is first expressed from the seeds, which are subsequently macerated with tepid water for several hours, and steam-distilled. The oil obtained is an extremely powerful irritant owing to its volatility and penetrating power, and is responsible for the painful nature of blisters caused by mustard. Diluted with 50 times its volume of alcohol, or in the form of liniment, it is employed as a counter-irritant and rubefacient. It is also used in cases of pleurisy and pneumonia.

Black mustard is ground with white mustard for preparing table mustard, and also various medicinal mustard preparations, such as bath mustard, mustard bran, and mustard flour. The expressed oil has mild rubefacient properties and is used as a liniment. The technical oil obtained during the preparation of mustard also contains the oil from white mustard seeds. In Europe it is used for making soap, for burning, and as a lubricant. In India, the seeds of black mustard are used in pickles and curries.

B. oleracea Linn. THE WILD CABBAGE

D.E.P., I, 533; C.P., 182; Bailey, I, 542.

The wild cabbage is a native of the coastal regions of England, and southern and western Europe. It has given rise to several valuable varieties (cabbage, cauliflower, brussels sprouts, etc.), now cultivated as vegetable crops in many parts of the world. These differ in stem, leaf and inflorescence characters.

Var. **acephala** DC. KALE OR BORECOLE

D.E.P., I, 534; C.P., 182; Bailey, *loc. cit.*

HIND.—*Karam-sag.*

A tall pot-herb, with curled leaves, which are sometimes coloured. They do not form a head as in the cabbage. In collards, one of the types, the leaves are smooth, and form a rosette at the apex of the stem.

Kale is grown in Assam, Bombay, Baroda, and Kashmir. It prefers a sandy loamy soil, and requires large quantities of fertilizers. The seeds are sown during Aug.–Nov. in the plains, and during March–May, or Aug.–Nov. on the hills. The crop is ready for harvesting in 90–120 days. The young shoots and leaves are used as greens.

Kale contains: protein, 3·9; fat, 0·6; carbohydrates, 6·0; crude fibre, 1·2; ash, 1·7; calcium, 0·195; phosphorus, 0·06%; iron, 2·5 mg.; vitamin A, 11,000 I.U.; vitamin B_1, 190 µg.; vitamin B_2, 500 µg.; vitamin C, 150 mg./100g. (Heinz Co., Nutrit. Charts, 1942, 21).

Var. **botrytis** Linn. CAULIFLOWER, BROCCOLI

D.E.P., I, 534; C.P., 182; Bailey, *loc. cit.*, 542 & 693; Pl. XXXIV, 2.

HIND.—*Phul gobi.*

The edible portion of cauliflower is the white curd-like mass composed of a close aggregation of abortive flowers, developed on thick branches of the inflorescence. The cauliflower is cultivated in most parts of India, especially in the north-west, where it is grown on a large scale. The types called 'Patna', 'Snowball', and 'Forerunner' are popular in India. Broccoli, a late variety of cauliflower with larger leaves and smaller heads, is reported to be unsuitable for cultivation in the tropics.

Cauliflower is less hardy than cabbage and requires a cool, moist climate. It is grown either from imported seeds, or from seeds of acclimatized varieties. Seeds are sown between April–Sept. on the plains, and from Feb.–June on the hills. Seedlings about 2 weeks old are transplanted, with a spacing of about 20″, in rows 2–3′ apart. The crop is ready for harvesting in 180–200 days, before the heads begin to rise or become discoloured. The yield is 150–200 mds. per acre.

The plant thrives best on a rich loamy soil. It is heavily manured with well-rotted farmyard manure (at least 40 cart-loads per acre), and also with phosphates and cotton-seed meal. If the soil is deficient in boron, some borax is added to the fertilizer to prevent the curds from becoming brown, and the stems, hollow. Frequent top-dressing with small quantities of sulphate of ammonia or nitrate of soda is also essential.

The plants produce heads prematurely when kept too long in seed-beds, or if the soil is not sufficiently moist. Mutilation of root system and low temperature during early stages of growth also lead to the same undesirable result. If the growing heads are not protected from sun and rain, they become brown, and numerous leaves appear between segments of the curd. Foliage leaves of the plant are tied over the head to blanch it. Hot weather may produce a 'fuzziness' caused by the floral parts rising above the surface of the head, or a 'riciness' caused by the elongation of branches bearing the flower clusters. Sometimes, this also causes leaves to appear between segments of the curd. Cauliflower needs plenty of water. Frequent irrigation (5–6 days for the early plantings, and 10–15 days for late crop) is necessary to ensure good size and yield.

Cauliflower, cabbage, and turnip, as well as some of the other members of the cruciferae are subject to fungal diseases such as the 'downy mildew', (*Peronospora parasitica* Tul.), the white rust (*Cystopus candidus* Lev.), and the blight (*Alternaria brassicae* Sacc.), the last being the most destructive. The usual remedy is to spray a fungicide like Bordeaux mixture. The cabbage Aphis, the 'painted bug' and caterpillars of the cabbage butterfly are the usual insect pests. The cabbage Aphis is controlled by spraying with tobacco solution or weak soap solution. A rosin compound is recommended for the painted bug (rosin, grade 3, 12 lb.; sodium carbonate, 2 lb.; water, 18 gals. Purewal, 86 & 91).

Cauliflower is used as a vegetable in curries, soup, etc., and is also pickled. In places where production is large, it is dried and preserved for use in the off-season. Small seedlings are used as greens.

Cauliflower contains: moisture, 89·4; protein, 5·3; fat, 0·4; carbohydrates, 5·3; mineral matter, 1·4; calcium, 0·03; phosphorus, 0·06%; iron, 1·3 mg.; vitamin A, 38 I.U.; vitamin B_1, 110 I.U.; vitamin C, 66 mg./100 g. (*Hlth. Bull.*, No. 23, 1941, 32).

Sprouting broccoli (var. *italica* Plenck.) produces small green flowering heads somewhat resembling cauliflower. When terminal heads are removed, small heads are produced on lateral shoots.

Var. **capitata** Linn. THE CABBAGE

D.E.P., I, 534; C.P. 182; Bailey, *loc. cit.*, 603; Pl. XXXIV, 1.

HIND.—*Band gobi*; KAN.—*Kosu gadde*.

The cabbage, a native of some of the coastal regions of Europe, thrives best in temperate climates. In India, it is cultivated on the hills, and during the cold season also in the plains. Although a biennial, it is grown as an annual crop. There are numerous forms of the cabbage, of which the Sugar loaf, with conical heads, the Ball-head, and the Drum-head are popular in India.

The plant does not set seed in India, and hence, seeds are procured from America or southern Europe. Recently attempts have been made to raise seeds in the prolonged cold weather of Kashmir and N.W.F.P. (Burns, *Indian Fmg.*, 1943, **4**, 69). In the plains, the sowing season is July–Nov. whereas on the hills, it is Feb.–May and Oct.–Nov. An acre of land requires 6–8 oz. of seed. When the seedlings are 3–4″ high, they are transplanted into rows 2–2½′ apart. The crop is harvested in 90–120 days, when the heads attain their full size and are hard. The weight of cabbage ranges from 2–12 lb. and the yield is 200–300 mds. per acre.

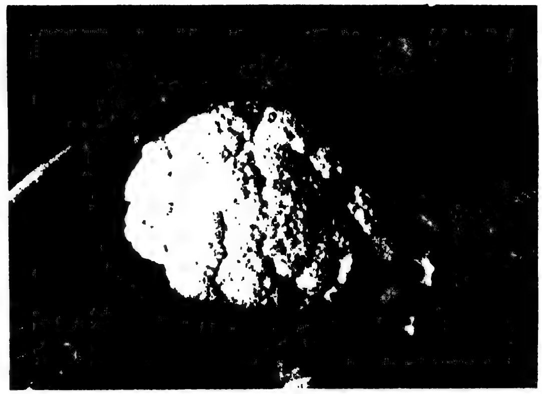
The crop requires frequent irrigation and heavy manuring. Well-rotted farmyard manure (40 cartloads per acre) should be incorporated into the soil by 3–4 ploughings. Nitrate of soda at the rate of 2 mds. per acre should also be used as a top-dressing. Good tillage has to be continued as late as possible even at the risk of injury to outer leaves (Purewal, *loc. cit.*, 31).

Cabbage is an important vegetable, and is used in curries, pickles, etc. It is also used for feeding stock and chicken. Sauerkraut, a favourite food in Russia, Germany and the U.S.A., is made by fermenting chopped, ground, or sliced cabbage in its own juice, with a little salt added to it.

Cabbage contains: moisture, 90·2; protein, 1·8; fat, 0·1; fibre, 1·0; carbohydrates, 6·3; mineral matter, 0·6; calcium, 0·03; phosphorus, 0·05%; iron, 0·8 mg., vitamin A, 2,000 I.U.; vitamin B_1, 50 I. U.; vitamin C, 124 mg./100 g. (*Hlth. Bull., loc. cit.*, 29).

Pak-choi (*B. chinensis* Linn.) and *Pe-Tsai* (*B. pekinensis* Rupr.), both known as Chinese cabbage,

1. CABBAGE (BRASSICA OLERACEA VAR. CAPITATA)



2. CAULIFLOWER
(BRASSICA OLERACEA VAR. BOTRYTIS)

4. KNOL - KOHL
(BRASSICA OLERACEA VAR
GONGYLODES)

3. BRUSSELS SPROUTS (BRASSICA
OLERACEA VAR. GEMMIFERA)

5. TURNIP
(BRASSICA RAPA)

are grown to a limited extent in India. The former does not produce any heads, while the latter develops compact and long heads.

Var. **gemmifera** DC. BRUSSELS SPROUTS

D.E.P., I, 534 ; C.P., 182 ; Bailey, *loc. cit.*, 542 ; Pl. XXXIV, 3.

A species in which the stem, 2-3′ high, bears a large number of delicately flavoured small sprouts or heads, crowded along its length in the upper portion. It is cultivated mainly in Bombay and Baroda. It requires a cool climate, and a fertile heavy soil, with a constant supply of moisture. On the hills, the seeds are sown during Feb.-March, and in the plains, during Aug.-Oct. Harvesting is done during Feb.-May in the plains, and during July-Sept. on the hills.

A liquid manure containing superphosphate and potassium sulphate (4 : 1) is given once a fortnight from the time the plants are 1′ high. Sprout formation is induced by pinching off the tips of stems. When they are forming, manuring with ammonium sulphate or sodium nitrate is beneficial.

The buds, 1-2″ in diameter are used in the same way as cabbage. They contain : moisture, 84·6 ; protein, 4·7 ; fat, 0·5 ; carbohydrate, 9·2 ; mineral matter, 1·0 ; calcium, 0·05; phosphorus 0·08% ; iron, 2·3 mg. ; vitamin A, 210 I.U. ; vitamin C, 72 mg./100 g. (*Hlth. Bull.*, *loc. cit.*, 29).

Var. **gongylodes** Linn. Syn. var. *caulorapa* DC. KOHLRABI, KNOL-KOHL

D. E. P., I, 534 ; C.P., 192 ; Bailey, *loc. cit.*, 542 ; Pl. XXXIV, 4.

HIND. & BENG.—*Ganth gobi.*

In this variety, the short stem enlarges into a spherical edible portion, with large leaf scars on its outer surface. It is grown mainly in Bombay, Baroda, Assam, the U. P., the C. P., and the Punjab. There are two types : green and purple. Seeds are sown in the plains, from Aug.-Oct., or in January, and on the hills from Feb.-May. Kohlrabi thrives in rich garden soil and requires the same culture as cabbage. The crop is harvested 40-60 days after sowing (yield, 150-200 mds. per acre). The stem is used as a vegetable only when tender, as it becomes tough and stringy later.

Knol-kohl contains : moisture, 92·1 ; protein, 1·1 ; fat, 0·2 ; carbohydrate, 5·9 ; mineral matter, 0·7 ; calcium, 0·02 ; phosphorus, 0·04% ; iron, 0·4 mg. ; vitamin A, 36 I.U. ; vitamin C, 85 mg./100g. (*Hlth. Bull.*, *loc. cit.*, 33).

B. rapa Linn. TURNIP

Bailey, *loc. cit.*, 543 ; Pl. XXXIV, 5.

HIND.—*Salgam.*

A native of Europe, or western Asia. It is a biennial, producing in the first year, a swollen, fleshy tap-root (conical to flat), and a rosette of hairy leaves ; and in the next year, a stem 1-3′ high, bearing leaves and flowers. But in cultivation, it is grown as an annual. Its fleshy roots are edible. It is grown as a cold season crop in the plains of the Punjab, the U.P., etc., and is sometimes grown on the hills.

Seeds from acclimatized varieties like Turnip Red, and Turnip White are sown during July-Aug., and those of imported varieties (the Snowball, White Queen, etc.), are sown from September onwards. Although turnip is grown on all kinds of soil, it thrives best on deep rich loam, and requires only limited manuring (8-10 cart-loads of farmyard manure per acre). Seeds are broadcast and seedlings are thinned and spaced 5-6″ apart. Turnip also requires frequent irrigation, and the crop is harvested in 45-70 days. In hot weather, or when growth is slow for want of water, etc., the turnip quickly becomes woody and bitter (for diseases, *vide* p. 220).

Turnip (root) contains : moisture, 91·1 ; protein, 0·5 ; fat, 0·2 ; carbohydrate, 7·6 ; mineral matter, 0·6 ; calcium, 0·03 ; phosphorus, 0·04% ; iron, 0·4 mg.; vitamin A, trace ; vitamin B_1, 40 I.U. ; vitamin C, 43 mg./100 g. (*Hlth. Bull.*, *loc. cit.*, 34).

Turnips are used in curries, pickles, etc., and the tender leaves are used as greens.

Rutabaga or Swedes, *B. napobrassica* Mill. resembles the turnip in general appearance, but differs from it in having a denser and larger root, which is rounded or elongated. Its flesh is white or yellowish. The crop requires 90-100 days to mature.

B. tournefortii Gouan PUNJAB RAI

D.E.P., I, 534 ; Fl. Br. Ind., I, 156.

This species, which is self-fertile, is easily distinguished from other brassicas by its much-lobed lower leaves, and small pale-yellow flowers. The former are covered with bristly hair, and spread on the ground.

In the Punjab, it is commonly grown in the central districts, on the borders of fields, and does not appear to have extended eastwards beyond Delhi and Ajmer. It is reported to be cultivated in western Tibet as an oil-seed crop.

The seeds contain 30·7% of fixed oil.

MUSTARD OIL AND CAKE

Mustard oil, the fatty oil from oleiferous brassicas is the principal edible oil of northern India. The pungent-smelling oil obtained from *ghanis* is generally preferred for edible purposes. During crushing 2–4% of water is added and the oil is pressed out (1½–2 hrs.) at a temperature of 38–40°. These conditions are best suited for the complete hydrolysis of the glucosidic constituents of the seeds. The fatty oil pressed out (30–33% of seeds) has a strong odour and contains 1·45% of allyl isothiocyanate. The oil obtained from expellers and hydraulic presses does not possess this pungent odour. Athawale *et al.* (*loc. cit.*) have suggested preliminary milling of seeds, mixing the meal with 3–4% water, and cooking at 40–50°, for 45 minutes. The meal is then pressed twice and the oil obtained is similar to *ghani* oil.

The crude oil is dark-brown in colour and it is generally refined by treating it with 0·5–1·5% of strong sulphuric acid, which precipitates impurities and colouring matters. After settling, the oil is repeatedly washed with hot water, and when thus refined, it is yellow in colour. Refining by means of caustic soda removes free acids and the soap stock obtained is used in the manufacture of soft soap.

Mustard oil has a characteristic sharp taste and odour, and is slightly more viscous than other ordinary vegetable oils. The oil does not readily thicken when heated or exposed to air, and is placed between non-drying and semi-drying oils. Owing to the usually mixed nature of seeds, varying constants have been reported for the oil, and the following are some of the specifications for Indian mustard oil (Athawale *et al., loc. cit.*) :

	Sap. val.	Iod. val.
Bengal	169–71	96–108
U.P., C.P. and Bihar	169–175	96–108
Punjab and N.W.F.P.	170–180	93–105
Indian Stores Dep. Specif. (1937).	170–178	93–108

The commonly used adulterants are groundnut oil, linseed oil, sesame oil, occasionally, niger seed oil and even mineral oil.

The Mexican Poppy (*Argemone mexicana*) is frequently found growing in brassica fields, and, if proper care is not taken during cultivation, its seeds get mixed with those of brassica and the oil expressed contains also argemone oil (sometimes 3–5%). Its presence in edible mustard oil is injurious, and outbreaks of epidemic dropsy are probably due to it (Chopra, Pasricha and Banerjee, *Indian med. Gaz.*, 1940, **75**, 261). The following tests are recommended for determining the limit of argemone oil in mustard oil (I. P.L., 92):

(*i*) When shaken with an equal volume of nitric acid, it should not develop a brownish-red or orange colour.

(*ii*) 3 c.c. of the oil are treated with 1 c.c. of glacial acetic acid and 3 c.c. of a 3% aqueous solution of copper acetate, and heated in a water bath for 15 minutes, well shaken and allowed to stand. There should be no precipitate or change of colour from blue to green in the aqueous layer (*vide* also Sarkar and Rahman, *Curr. Sci.*, 1945, **14**, 196).

In northern India (especially in Bengal) mustard oil is the most important edible oil. It also finds medicinal applications and is used for massage and 'oil-baths'. Inferior grades are employed as lighting oil.

In Europe, colza (refined rape oil) is used as salad oil, and in some parts as edible oil. It is also used as 'bread oil'. To improve the appearance of loaves, before baking, their sides are coated with this oil. Hydrogenated colza oil is also used for the preparation of butter substitutes. Inferior grades are used as burning oil and for the preparation of Turkey red oil.

The most important technical use of rape oil is as a lubricant. For this purpose, refined oil as well as blown oil are employed. When blown oil is to be used as such, it should not contain more than 3% of free fatty acids. But when used in admixture with mineral oils, the presence of a small percentage (1–2%) of free fatty acids has been found to greatly improve its lubricating properties (Jamieson, 229). Some rape oil is also used for quenching steel plates, and for the manufacture of soft soap.

Mineral axle oil containing 20% of blown rape oil, developed by Bhatnagar and Ward, is being manufactured by the Attock Oil Company,

Rawalpindi, for use in railways (*Rep. Tech. Wk. Bd. sci. & industr. Res.*, 1940-41, 56). Rape oil can be used as fuel in diesel engines although the consumption is slightly higher than when mineral oil is used (Aggarwal, Chowdhury, Mukerji & Verman, *Bull. Indian Industr. Res.*, No. 19, 1943, 23 & 38). A mixture of castor oil and rape oil (1:1) containing 1% of α-napththlyamine can be used as a lubricant in internal combustion engines (*ib.*, *Bull.* No. 20, 1944, 71). Narayanamurti, Ranganathan & Roy (*Indian For. Leafl.*, No. 58, 1943) have found that fairly satisfactory plywood adhesives can be prepared from rape seed proteins.

In India, mustard seeds (*rai*) are often used as spice, especially in the preparation of pickles. But table mustard is essentially of European origin and is not used by Indians. It consists of a suitably blended mixture of the flours of black and white mustards. Its use as a condiment is very general in Europe and America.

Ground mustard or mustard flour is usually prepared from mustard seeds after the removal of bran. Sometimes a portion of the fixed oil is also pressed out, and the press cake is ground and bolted. In preparing mustard paste or 'prepared mustard', mustard flour is ground with salt and vinegar, and sometimes also with spices such as coriander, cloves, cinnamon, etc. In American practice, the seeds of *B. juncea* are also employed for the preparation of mustard.

Rape or mustard cake is used for feeding cattle. *Ghani* cake is preferred because of its higher oil content (10·5–15%), but expeller cake (oil content, 7·8·5%), known as *papri* cake, is said to have better keeping qualities. Rape seed meal subjected to solvent extraction is generally used by hop growers (Imp. Inst., Lond., Rep. Oil-seeds, 1920, 110). Rape seed meal contains : N, 4·9 ; P_2O_5, 2·5 ; K O, 1·5% (*Bull. imp. Inst., Lond.*, 1915, **13**, 458). In India, inferior grades of cake are used as manure for sugarcane in Bihar, and for tea in Assam.

The cake has a somewhat pungent and bitter taste, and is said to be disliked by cattle, but not by sheep. On the Continent, it is largely used as a feeding stuff for cattle. But, in the U. K., there is a prejudice against it because of the frequent presence of mustard seeds, especially in cakes of Indian origin. It is mostly used as a manure for potatoes and other root crops, and as a top-dressing for wheat and barley.

TABLE III

COMPOSITION OF BRASSICA OIL-SEED CAKES

(Per cent.)

		Moisture	Protein	Oil	Carbohydrate (soluble)	Fibre	Ash
1. *Sarson**	(*a*)..	36·0		11·1	32·8	10·1	100
2. *Toria**	(,,)..	33·8		12·5	34·1	11·2	7·5
3. Rape*	(,,)..	36·4		13·4	33·2	7.7	9·3
4. Mustard seed	(*b*)	12	18·0	7·5	40·0	17·5	5·0

*Moisture-free

(*a*) *Imp. Coun. Agric. Res., Misc. Bull.*, No. 25, 1946, 20 ; (*b*) *Bull. Minist. Agric., Lond.*, No. 124, 1945, 3.

ACREAGE AND PRODUCTION OF RAPE AND MUSTARD

China and India are the two biggest rape producing countries in the world, China's production being more than double that of India.

TABLE IV

WORLD ACREAGE AND PRODUCTION OF RAPE SEED IN 1938

	Acreage (*a*) (1,000 acres)	Production (*b*) (1,000 tons)
India . .	5,478*	1,017
China (1936) .	9,706	2,440
Japan . .	274	114
Roumania . .	205	52
Poland . .	163	70
Germany . .	153	126
Other countries .	150	61

* Includes mustard and also the area under mixed crop.

(*a*) *Int. Yearb. Agric. Statist.*, '38-39, 344–345 ; (*b*) *Statist. Yearb. Leag. Nations*, 1944, 129.

Among the oil-seed crops of India, rape and mustard occupy the second place, groundnut being the first. However, the area under cultivation, and production, have not shown any marked increase as in the case of groundnuts.

TABLE V

AVERAGE ANNUAL ACREAGE, PRODUCTION AND YIELD PER ACRE OF RAPE AND MUSTARD IN INDIA

	Area (1,000 acres)	Yield (1,000 tons)	Yield per acre (lb.)
'00–01/'09–10	5,827	1,001	315
'10–11/'19–20	6,292	1,149	412
'30–31/'39–40	6,023	1,036	383
'39–40/'44–45	5,810	1,038	401

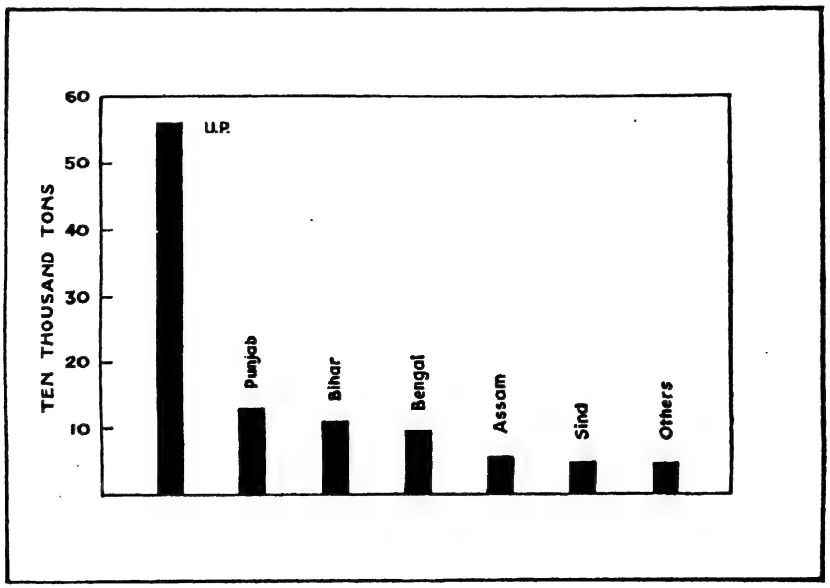
TABLE VI

DISTRIBUTION OF ACREAGE AND PRODUCTION OF RAPE & MUSTARD IN INDIA *

Provinces and States	Area in 1,000 acres		Per cent. of total area		Yield in 1,000 tons		Per cent. of total yield	
	'34-35/'43-44 (Av.)	'44-45	'34-35/'43-44 (Av.)	'44-45	'34-35/'43-44	'44-45	'34-35/'43-44 (Av.)	'44-45
U.P. (Pure crop)	242	177	4·0	3·2	44	36	4·1	3·5
U.P. (Mixed crop)	2,485	2,559	41·2	45·9	449	524	42·3	50·7
Punjab	867	861	14·4	15·4	128	129	12·1	12·5
Bengal	767	549	12·7	9·8	154	93	14·5	9·0
Bihar	514	509	8·5	9·1	110	109	10·4	10·5
Assam	368	315	6·1	5·6	56	54	5·3	5·2
Sind & Khairpur States	207	251	3·4	4·5	26	47	2·5	4·5
Others	586	360	9·7	6·5	96	45	9·8	4·1
Total	6,036	5,581†	..	..	1,063	1,037†	..	..

* *Vide* map opposite last page. † Non-reporting areas not included.

PRODUCTION OF RAPE AND MUSTARD IN INDIA IN '44-45



Excepting a small area in the south where *B. nigra* is grown, rape and mustard are cultivated over the entire northern belt of India from the Punjab, the N.W.F.P. and Sind in the west, to Bengal and Assam in the east. The U. P. has by far the largest area under rape and mustard with a considerable portion of it under mixed crop. The other producing areas, in the order of importance are, the Punjab, Bengal, Bihar and Assam. These areas together account for over 90% of total annual production. Areas of some importance included in 'others' are the N.W.F.P., the C. P. and Berar, and Alwar.

Rape and mustard form the principal source of edible mustard oil in northern India. Over 90% of the entire crop is consumed in the country, and only a small proportion (seed and oil) is exported. During '34-35/'38-39, the average annual production of seeds was 1,004,000 tons. Annual imports from Nepal were 13,000 tons, and exports, 30,000 tons, and the net balance, 987,000 tons. Out of this approximately 16,000 tons were for seed (@ 6 lb. per acre), and another 20,000 tons for use as condiment, etc. The rest of the crop was crushed in *ghanis* or power mills for mustard oil.

TABLE VII

AVERAGE ANNUAL QUANTITY OF SEEDS CRUSHED DURING '34-35/'38-39

(1,000 tons)

	Ghanis	Power mills	Total seed	Oil produced
Bengal	125	175	300	100
Bihar	50	100	150	50
Punjab	25	45	70	23
U. P.	200	125	325	108
Others	35	45	80	27
Total	435	490	925	308

The principal surplus areas in India are the U. P. and the Punjab. Bengal is the most prominent importing area and is followed by Bihar. The U. P. is the largest producer of oil, and before the Second World War, her average annual surplus was 20,000–30,000 tons. The estimated surpluses in '46-47 were 82,000 tons of seeds, and 69,000 tons of oil, the U. P. accounting for 20,000 tons of seeds, and 58,000 tons of oil (Food Dep., Govt. of India).

TABLE VIII

INTERNAL TRADE (RAIL AND RIVER-BORNE) IN RAPE AND MUSTARD SEEDS *

(1,000 tons)

	Imports			Exports		
	'36-37/'38-39 Annual av.	'39-40/'41-42 Annual av.	'43-44§	'36-37/'38-39 Annual av.	'39-40/'41-42 Annual av.	'43-44
Bengal	151·5	166·7	147·3	0·9	0·4	0·4
U. P.	13·4	7·9	12·2	120·2	148·0	78·8
Punjab (*a*)	4·5	5·6	22·3	64·2	30·4	52·0
Bihar and Orissa	50·7	42·1	13·4	12·6	21·4	4·7
C. P. & Berar	0·4	0·3	0·2	14·3	8·9	4·5
Sind & Baluchistan	25·1	21·8	1·5	0·1	9·2	10·1
Others	7·6	11·2	8·8	40·9	37·3	55·2
Total	253·2	255·6	205·7	253·2	264·6	205·7

(*a*) Including Delhi and the N.W.F.P.; § Unrevised; *The Food Statistics of India, 1946, 99.

In recent years, the internal consumption of fats and oils has shown a rapid increase, and the major producing areas have been expanding their oil-crushing industry, utilizing much of their surplus production of oil-seeds. As a consequence, the oil mills in Bengal have been severely hit, and this province, the principal consumer of mustard oil, is now suffering from an acute shortage.

Rape and mustard do not occupy a prominent position in international trade, and most of the seeds are consumed within producing countries. The net world exports during '09–13 amounted to an annual average of 374,000 tons, about 25% of total production (Bahl, 16). India was the principal exporter and her average annual exports were of the order of 260,000 tons, and the rest of the exports were contributed by Roumania and China. Germany was the principal buyer, followed by France, the U. K., Netherlands and Belgium (Imp. Econ. Comm., London, Vegetable Oils and Oil-seeds, 1936, 36). After the First World War, the total exports have shown considerable decline and have often been less than 1/3 the average of the pre-War period.

In recent years, both the exports and imports of different countries have shown wide fluctuations. In '38, India and Roumania were the principal exporting countries. European markets were supplied by India, Roumania and other Balkan countries. Chinese exports used to go almost entirely to Japan.

Japan used to be the only country exporting substantial quantities of rape oil.

TABLE IX

EXPORT OF RAPE AND MUSTARD SEED FROM INDIA

	Rape		Mustard	
	Qty. (1,000 tons)	Value (lakhs of Rs.)	Qty. (1,000 tons)	Value (lakhs of Rs.)
'34-35/'38-39 (Av.)	28	36·8	2·6	4·5
'39-40	22	32·8	3·0	6·7
'40-41	35	46·9	4·0	9·6
'41-42	34	45·6	0·7	1·2
'42-43	35	66·3	1·4	3·4
'43-44	18	57·1	0·4	1·7
'44-45	17	60·4	0·2	1·1
'45-46	22	85·8	0·4	2·0

Rape seed is exported mainly from Karachi, and mustard seed from Bombay (98% and 84% respectively during '34–35/'38–39). The principal importing countries during this period were the U. K. (35%), France (16·3%), Netherlands (14·8%), Italy (11·1%) and Germany (7·5%). Most of the Indian mustard went to France (60·4%).

TABLE X

EXPORT OF RAPE AND MUSTARD OIL

(1 ton=246 gal.)

	Qty. (Tons)	Value (Lakhs of Rs.)
'29-30/'33 34	959*	4·27*
'34-35/'38 39	901*	3·15*
'39-40	1373	5·04
'40-41	1628	5·65
'41-42	1244	4·66
'42-43	198	1·21
'43-44	20	0·26
'44-45	39	0·58
'45-46	72	1·01

Exports to Burma not included.

TABLE XI

VARIETIES OF RAPE AND MUSTARD RECOGNISED IN INDIAN EXPORT TRADE*

Trade name	Variety	Refraction limits	Principal ports of export
Yellow Guzerat (from Gujarat)	Yellow *sarson*	10% of brown seeds	Bombay
Yellow Cawnpore (from western U.P.)	do.	15% of brown seeds	Calcutta
Bold Ferozepore	Brown *sarson*	30% of grains which pass through No. 10 sieve.	Bombay & Calcutta
Bold brown Cawnpore	do.		
Toria	*Toria*	0·5% of *jamba* seeds and 2·5 % dirt.	Karachi
Mustard seeds	*Rai, Benarsi rai*	..	Bombay

*Ex Central Agric. Marketing Dep.

The oil used to be exported mainly from Bengal ports. In normal times, Burma was the principal importer. During '29-30/'38-39, her average import amounted to 880 tons. The other importing countries were Mauritius, the Fiji Islands, etc. Exports of oil decreased very considerably during the latter portion of the Second World War, and have not shown any marked rise subsequently owing to increased internal demand for edible oils and fats.

TABLE XII

PRICES OF RAPE AND MUSTARD SEED
(Rs. per Md.)

	Calcutta	Cawnpore	Karachi
'38–39	5/15	4/13	4/9
'39–40	6/11	5/2	5/7
'40–41	6/7	4/6	4/13
'41–42	5/13	4/13	5/2
'42–43	8/10	7/2	8/4
'43–44	19/6	14/15	12/13
'44–45	18/15	14/2	14/4

Prices in Karachi (the biggest exporting centre) closely follow the market rates prevailing in London, whereas those at Calcutta are, in addition, influenced by the local demand from oil mills.

TABLE XIII

PRICE OF RAPE AND MUSTARD OIL AND CAKE
(Rs. per Md.)

	Calcutta		Cawnpore	
	Oil	Cake	Oil	Cake
38–39	15/3	..	12/9	..
39–40	14/4	2/1	13/1	1/14
40–41	13/11	1/14	12/10	1/9
41–42	13/4	1/12	11/9	1/10
42–43	22/11	2/9	20/1	2/11
43–44	45/13	5/10	36/10	4/3
44–45	45/2	6/14	36/14	2/15

The increase in prices in recent years of rape and mustard oils has followed the general rise in prices of other edible oils and food-stuffs, and has been further influenced by restrictions placed on the interprovincial movement of seeds. The price of first grade oil at Calcutta soared up to Rs. 58 per maund in September '43, and consequently for sometime the controlled rate was fixed at Rs. 47/8.

The *ghani* cake fetches a slightly higher price, 4 to 6 As. more per maund than the expeller variety.

Bread fruit, see **Artocarpus communis**

BREYNIA Forst. EUPHORBIACEAE

D. E. P., I, 534; Fl. Br. Ind., V, 329.

A genus consisting of 25 species of shrubs and small trees, of which 6 are represented in India. *B. patens* Benth. and *B. rhamnoides* Muell. Arg. are medicinal (Kirt. & Basu, III, 2236). The wood of both is hard and close-grained, that of *B. patens* being white and that of *B. rhamnoides*, reddish-brown (Gamble, 604). The latter is a good hedge plant.

BRIDELIA Willd. EUPHORBIACEAE

A genus of trees, shrubs or climbers, comprising about 60 spp., distributed from tropical Africa and Madagascar, eastward through the Indo-Malayan region and southern China to tropical Australia and the Pacific Islands. There are about 18 Indian spp. *B. monoica* (Lour.) Merril, *B. montana* Willd. and *B. retusa* are minor timber trees.

The bark of some species is astringent. According to Talbot (II, 437), the fruits of *B. stipularis* Blume yield a black colouring matter.

B. retusa Spreng.

D. E. P., I, 536; Fl. Br. Ind., V, 268; Beddome, Pl. 260.

HIND.—*Ekdania, gondui, khaja*; BENG.—*Geio*; MAR.—*Asana, kanta-kauchi, kutki*; GUJ.—*Monj*; TEL.—*Bontha-yepi*; TAM.—*Mullu-vengai*; KAN.—*Goje*; MAL.—*Mukkayini*; BURM.—*Seikchi*.

A moderate-sized tree, with a straight cylindrical bole up to 30′ in height and 6–7′ in girth, found widely distributed throughout India and Burma.

The wood is moderately heavy (sp. gr., 0·75; air-dry wt., 47 lb. per c. ft.), drab to olive-brown with interlocked grain and medium texture. It is somewhat difficult to season and is liable to serious defects when drying. It is moderately hard and fairly durable. The timber lasts longer when in contact with water. It saws and machines well, works to a smooth surface, and is suitable for turnery and carving. It presents a fine

mottled appearance if quartered (Pearson and Brown, II, 877).

It is a second class timber used in constructional work for house-posts, rafters, floor-boards, etc. It is also used for making carts and agricultural implements. Supplies are available from Bombay, Bengal, Bihar and Orissa. During pre-War years (1937), the price of this timber in Bengal was Rs. 19-31, and in Bihar, Rs. 22-25 per ton in log form. In Orissa, it was available at Rs. 19 per ton. In Bombay, the price used to fluctuate from Rs. 9-35 per ton (Trotter, 1944, 65).

The bark contains tannin (16-40%, *Indian For. Leafl.*, No. 72, 1944, 5) and it is used for tanning. The fruits are edible and the leaves serve as cattle-fodder.

Brinjal, see **Solanum melongena**

BRISTLES

Matthews' Textile Fibres, 1947, 669; *Dep. Comm., U.S.A., For. Comm. Weekly*, 1943, **11**, No 12, 2; Pl. XXVII, 3.

Bristles are the stiff, wiry hairs of some mammals especially pigs, hogs and wild boars, used for making various types of brushes. They are generally obtained from the back and neck, those growing on the flanks and belly being too short. Bristles, like animal hair, consist of three layers: the medulla or the central core, surrounded by the cortex and the epidermis. The medulla contains pigments and is not so prominent as in hair; the cortex, consisting of tightly packed elongated cells, imparts hardness to the bristle; the epidermis is made up of microscopic scales having fine serrated edges.

Pig bristles are coarse and stiff, and taper from base to tip, and have 'splits' or 'flagged tips' which make them eminently suitable for paint and varnish work, owing to their paint-holding characteristics. The taper gives the brush its pliability.

Until the early part of the present century the bulk of world supply of pig bristles used to come from Russia, including Siberia and Poland, and the remainder mostly from China. Owing to decline in Russian supply, China now holds the leading position. During '36-39, China exported nearly 9 million lb. a year and during '46, 10·5 million lb.

The yield and quality of bristles depend on the breed of pigs, the locality and climate. A cool climate is very favourable for the production of bristles, while better feeding and housing of animals have an adverse effect on their growth. The best bristles are obtained from semi-wild pigs or boars. Siberian pigs are stated to yield long bristles, coarser in texture than Chinese bristles. Indian bristles are also wellknown for their coarseness and stiffness. Bristles are plucked from living animals, once or twice a year. They are also pulled out from dead or slaughtered animals. Sometimes short hairs left in the carcass are also shaved and collected. In the U.P., about an ounce of bristles is obtained from a pig.

Bristles from living animals are superior to those obtained from carcasses, the latter being deficient in lusture and resilience. However, no distinction is made for use in brushware, or for export.

Indian bristles are stout and strong, but not so 'lively' as those from other countries. They have a longer 'flag' (30-50% of total length) which has to be trimmed off before use. This decreases their value. They taper prominently and have a characteristic orange to reddish tinge at the flag. Sometimes this is so pronounced that they are called 'O.B.' (orange bristle) and fetch a slightly higher price.

Indian bristles are available in all colours: white, black or grey. Grey is the predominating colour and is often subdivided into dark and light. The whites are difficult to obtain and are available mainly in western U.P. and the Punjab. The blacks are less in evidence. The grey varieties are obtainable in two qualities: extra stiff and stiff. The former is obtained from semi-wild pigs in distant villages, and the latter, from domesticated pigs in the neighbourhood of cities and larger villages.

The length of a bristle is an important factor; the longer the bristle the more valuable it is. In any particular quality, thickness increases with length, and hence longer bristles are stiffer. Due to warmer climate, Indian pigs do not grow very long bristles. They vary in length from $2\frac{1}{4}''$-$6\frac{3}{4}''$, and occasionally longer.

Indian bristles are mostly obtained from domestic or semi-wild pigs in the U.P., C.P., and Punjab. Some bristles are also collected from wild boars in the Punjab, the C.P. and Bhopal. A superior type of

bristle known as the 'Darjeeling' bristle is obtained from the boar frequenting the foothills of the Himalayan mountains. These are black bristles similar to the Chinese variety, but have slightly more 'flag'. For these Darjeeling is the central market.

Raw bristles are 'dressed' before use. They are washed and sorted according to length and colour, and cleaned and tied into bundles. Then they are soaked for a few hours in warm water containing soda ash, scoured with soap, thoroughly rinsed with cold water, and dried. The dried bristles are collected again and tied into bundles. The butt ends and flag ends should not get mixed at any stage, since their separation is difficult.

The dried bristles are finally graded into standard lengths by 'dragging'. 16–20 oz. of bristles are tied with a strap keeping all butt ends down on a small wooden platform. The longest bristles are first pulled out by hand, then the next smaller ones, and so on. The separate sizes are tied into bundles of about 4 oz., and finally the flag ends are trimmed off. One person can 'drag' 10–12 lb. of bristles in 6–8 hours. When dragging is not properly carried out, 'taper dressed' bristles are obtained which fetch a lower price. These have to be re-dragged, 'solid dressed' and sorted into bristles of uniform length and size. In Europe and U.S.A., machines are used for 'dragging'.

Cawnpore is the biggest dressing centre. The others are Jubbulpore, Allahabad and Berhaj Bazaar (Gorakhpur dist.), etc.

Bristles are sold usually in 5 grades, e.g., lily, white, yellow, grey and black. Ukraine provides the best lily and white grades. The standard grades recognised by the London market and adopted in India, are: 2" and 2¼" ('shorts'), 2½/3"; 3/3¼"; 3¼/3¾"; 3¾/4¼"; 4¼/4¾"; 4¾/5¼"; 5¼/5¾"; 5¾/6¼"; and 6¼"/ up. 'Riflings,' are the shortest lengths obtained after combing and shaking out bristles in bulk before they are dragged. These have butts and flags mixed together.

For certain brushes sterilisation of bristles is essential in order to destroy anthrax spores and bacteria. Messrs. Brushwares Ltd., Cawnpore, sterilise bristles by treating them with steam in an autoclave for about 1½ hours (25–40 lb. pressure). The disinfected wet bristles are then dried in ovens, when they regain their stiffness. Tooth-brush manufacturers for the army in India sterilise bristles by soaking them in dil. acids (sulphuric and hydrochloric), and washing and fumigating them with sulphur dioxide. Brushes made with these bristles are finally washed with a solution of hydrogen peroxide. This process also bleaches the bristles. Bristles are required to be sterilised immediately before use, and therefore when intended for export they are not sterilised.

Grey and black bristles are sometimes adulterated with horsehair or vegetable fibre. A brushmaker tests adulteration with horsehair by rolling the bristle between the thumb and the forefinger; a genuine bristle will slowly roll out of the fingers at the flag end.

Indian bristles are shipped to London in cases of 100 lb. net from Bombay, Karachi and Calcutta.

PRICES OF INDIAN BRISTLES

Grades	Shorts		2½/3" to 3¾/4¼"		4¼"/up	
	Dark	White	Dark	White	Dark	White
CAWNPORE PRICES IN RS. PER LB.						
Controlled rate in 1940	3/8	n.a.	6/4 to 14/8	n.a.	16/- to 25/-	n.a.
June, 1947	1/4	1/5	3/8 to 9/3	3/11 to 10/14	10/13 to 18/6	13/5 to 31/15
LONDON PRICES IN SHILLINGS PER LB.						
June, 1939	2/-	3/3	6/6 to 13/-	6/- to 12/6	13/6 to 24/-	13/6 to 64/-
Controlled rates during the War. . . .	7/-	7/-	12/2 to 27/8	16/- to 36/8	30/5 to 47/6	40/5 to 62/11
May, 1947	2/-	2/6	12/- to 24/6	12/9 to 25/6	33/6 to 150/-	37/- to 147/6

The consignments are sold by public auction during March, June, September and December. During the War ('39-45) they were in great demand mainly for the Army and exports were controlled by the Government.

AVERAGE ANNUAL EXPORT OF INDIAN BRISTLES

		Cwt.	Rs.
Quinquennium ending	'38-39	5,030	26,65,000
,,	'43-44	4,010	29,17,000
In	'44-45	2,370	31,93,000
	'45-46	3,740	61,81,000

U.K. was the principal buyer (79·46%) during '38-39, and since 1942 considerable amount is also going to the U.S.A.

Small quantities of Chinese bristles are imported into India, especially a fine soft black bristle with a small flag, which is eminently suited for flat varnish and shaving brushes.

There was a rapid increase in the prices of bristle after 1939, and prices were controlled both in India and in England. The controlled rate in India, for white bristle was 25% higher than for dark bristles. The prices of all varieties of bristles were further increased by another 25% in Feb. '42. The controlled rates in London showed little variation till the end of '46 when the prices of some grades went down, owing to accumulation of large stocks. In recent auctions, sizes 4¾″ and above fetched phenomenal prices owing to a heavy demand from a starved market.

Broccoli, see **Brassica oleracea** var. **botrytis**

BROMELIA Linn. BROMELIACEAE

D. E. P., I, 537.

A genus, composed of 12 species of herbs found in tropical America and the West Indies. They resemble the pine-apple (*Ananas comosus*) plant. *B. magdalenae* C. H. Wright of South America is the source of Pita fibre which is used for fine twine, lines, cordage, etc. *B. pinguin* Linn. etc. has been introduced into Ceylon and is now common in hedges near Negombo (Macmillan, 408). Its fibre, Pinguin, is inferior to 'Pita'.

BROMUS Linn. GRAMINEAE

D. E. P., I, 537; Fl. Br. Ind., VII, 357.

A genus, consisting of 100 species of grasses, (commonly known as brome grass) confined to the mountains of tropical and temperate regions. In India, nearly 10 species are found on the Himalayas and other mountains. Of these *B. asper* Murray, *B. inermis* Leyss., and *B. catharticus* Vahl. (syn. *B. unioloides* H.B. & K.) are good fodder grasses. *B. catharticus*, a native of South America, has been introduced into India, and has now run wild near Darjeeling and the Nilgiris. It is fairly drought-resistant, and is valued as a good winter grass in the U.S.A.

B. catharticus has been reported to act as a purgative. The grains of *B. mollis* Linn., another species found in India, are fatal to poultry, and cause giddiness in man and cattle (Caius, *J. Bombay nat. Hist. Soc.*, 1936, **38**, 551).

BROUSSONETIA L'Herit. MORACEAE

A genus of 3 species of trees or large shrubs native to east Asia. *B. papyrifera* has been introduced into India.

B. papyrifera Vent. THE PAPER-MULBERRY

D. E. P., I, 538; Fl. Br. Ind., V, 490; Pl. XXXII, 4.

BURM.—*Malaing, thale.*

This medium-sized tree is very common in China and Japan, where it is cultivated on the edges of fields. It is also found in Siam and on the hills of upper Burma. It was introduced into India near Dehra Dun, and has spread to the surrounding country. According to Troup (III, 891) it has become established in some of the irrigated parts of the Punjab, where it has spread from seeds and root-suckers. The trees prefer a cool climate, and thrive best on moist soils.

The Polynesians used to prepare Tapa cloth from the bark of this tree. The bast fibres of the plant are soft, lustrous, and very strong. They have long been used in China and Japan for making writing-paper, paper lanterns and umbrellas. In the Shan States the manufacture of rough paper from this plant is a cottage industry (Rodger, 82), but the trees are too scattered to permit large-scale exploitation. For obtaining paper-pulp the bast is pounded with water and boiled with half its weight of lime. The pulp is spread thinly over coarse muslin and allowed to dry to form the paper. When glazed black, it can be used like slates, for writing. After oiling it can also be used for umbrella covers.

BRUCEA J. F. Mill. SIMAROUBACEAE

A genus of six species of trees and shrubs distributed in the Old World tropics. Two are found in India. *B. antidysenterica* Lam. of tropical Africa is credited with antiperiodic and antidysenteric properties. *B. amarissima* occurring in Malaya and India is reported to possess similar properties.

B. amarissima (Lour.) Merril Syn. *B. sumatrana* Roxb.

Fl. Br. Ind., I, 521 ; Kirt. & Basu, Pl. 206.

A somewhat foetid, evergreen shrub up to 6′ high, found in Assam, Burma and Ceylon. The fruits are small drupes.

The Malays and Javanese use the leaves as a remedy for skin diseases. Mixed with unslaked lime they cure mange in animals. In Java, a decoction of roots is employed for fevers (Burkill, I, 372). The fruits are reputed to be a valuable remedy for tropical dysentery (Kraemer, 432).

The seeds contain 20% of fatty oil, two new bitter principles, small quantity of an ester, probably of butyric acid, and a compound of the formula, $C_{20}H_{34}O$, m.p., 130–133°, but no alkaloids. The bark yields a small quantity of greenish-yellow volatile oil of unpleasant odour and the proportion of bitter principles is less than in the fruits (Wehmer, II, 642). According to Henry and Brown (ex Chopra, 356) the bitter principles have no action on free-living protozoa.

BRUGUIERA Lam. RHIZOPHORACEAE

A genus of mangrove trees or shrubs, comprising some 6 paleotropical species, found from East Africa to the Pacific. Four species are met with in India, of which *B. conjugata* is a timber tree.

B. conjugata (Linn.) Merril Syn. *B. gymnorhiza* Lam.

D. E. P., I, 541 ; Fl. Br. Ind., II, 437; Brown, I, Pl. 18.

BENG.—*Kankra* ; TEL.—*Thuddaponna* ; TAM.—*Sigapukokandam* ; BURMA—*Byu-u-talon*.

A moderate-sized evergreen tree reaching 120′, found in the coastal forests of Sundarbans, Western India, Burma, Ceylon and the Andamans. The bark has many large, brown, corky pustules, and is almost black.

B. conjugata is a valuable tanniferous mangrove, and its bark may be utilised for the preparation of tannin extract. The average tannin content of Java bark has been found to be 28·5–32·2% (Burkill, I, 373). However, the proportion of tannin varies according to the source of the bark and the manner of its preparation. Pilgrim (*Indian For. Rec.*, 1923-24, **10**, 231) gives the following analysis of the various parts of the tree from Burma :

	Moisture	tannin	Sol. non-tans	Colour
Leaves	18·3	13·5	21·5	R 12·3 ; Y 47·0
Outer cortex (small trees)	14·6	·9	3·4	R 25·3 ; Y 59·6
Outer cortex (large trees)	14·2	10·8	3·4	R 23·0 ; Y 51·4
Twig bark	13·1	14·8	14·8	R 17·9 ; Y 45·1
Bole bark, inner portion (small trees)	16·2	31·7	16·8	R 19·5 ; Y 51·1
do. (large trees)	12·5	42·3	13·2	R 13·0 ; Y 50·0

On account of the high percentage of non-tannins, the leaves are not suited to the manufacture of extract, but may be used directly in tanning. In small scale experiments they have been found to yield a soft, supple, fawn-coloured leather. The air-dried bark from smaller trees (3′ girth) yields 46% of a solid extract (moisture, 5%) containing approx. 62% of tannin. Bark from larger trees (4–6′ girth) yields 53% of solid extract containing 72% of tannin (Pilgrim, *loc. cit.*). Mature bark shows less colour in proportion to tannin. According to Pilgrim, in the manufacture of extract, there is no advantage in separating the bark from the cortex.

The tannin is of the catechol class. The leather produced by direct tanning is of a reddish or orange buff colour, fairly stout, and suitable for sole leather. After tanning, treatment with *Hopea odorata* leaves, results in a supple leather of lighter colour (pale pink).

The wood is dull-red or reddish-brown, heavy (air-dry wt., 61 lb. per c.ft.), straight-grained, even and fine-textured. It is durable, strong, tough and extremely hard, and is difficult to saw and work. It is a refractory timber, difficult to season,

and is liable to develop long straight end-splits and surface cracks.

The wood is used in house construction for posts, beams, door-frames and planks. It is also used as firewood (cal. val. of moisture-free sapwood, 5,169 cals.; and of heartwood, 5,079 cals.—Krishna and Ramaswamy, *Indian For. Bull.*, *New Series*, No. 79, 1932, 12).

B. cylindrica Wight & Arn. Syn. *B. caryophylloides* Blume

Fl. Br. Ind., II, 438; Brown, *loc. cit.*, Pl. 21.

TAM.—*Kakandan.*

A small tree found in the tidal forests of Malabar and South Arcot, Burma, but rarely in Ceylon. It extends to the Malay Peninsula and Archipelago.

The wood is reddish, heavy, hard and close-grained. It is used for firewood and timber.

The bark is dark brown and contains, 15-19% of tannin, and 18-20% of non-tans. (Pilgrim, *loc. cit.*, 235). It is suitable for local use in sole-leather tannage. It gives a supple, light brownish-red leather. The colour may perhaps be reduced by treatment with *Hopea odorata* leaves. The dried leaves contain only 4·6% of tannin.

B. parviflora Wight & Arn.

Fl. Br. Ind., II, 438; Brown, *loc. cit.*, Pl. 23.

TEL.—*Vurada.*

A small tree, attaining a height of 70′, found in the tidal forests of Burma and the Andamans. It extends to the Malay Peninsula and Archipelago.

The leaves contain 12% of tannin, and are suitable for light leathers. The twig-bark contains 9·6% of tannin, while bole bark has only 5·5% (Pilgrim, *loc. cit.*, 236 & 262).

The timber is usually dull-yellow or brownish-yellow. It yields poles for fishing stakes and fish traps, and furnishes firewood of inferior quality (Burkill, I, 374).

B. sexangula Poir. Syn. *B. eriopetala* Wight & Arn.

Fl. Br. Ind., II, 438; Brown, *loc. cit.*, Pls. 19 & 20.

This tree sometimes attains a height of 100′ and is found in Malabar and Travancore, and extends to New Caledonia.

The timber is similar to that of *B. conjugata*. It is used for poles and firewood, and in Java, for house building.

The bark is almost black and contains 27·2% of tannin (Wehmer, II, 821).

BRUNELLA Linn. LABIATAE

D. E. P., I, 542: Fl. Br. Ind., IV, 670.

A genus, consisting of 5 species of herbs more or less cosmopolitan in distribution. *B. vulgaris* Linn. occurring on the Himalayas and on the hills of south India is considered to have expectorant and antispasmodic properties. The leaves are used in piles as an external application (Kirt. & Basu, III, 2007).

BRUNFELSIA Linn. SOLANACEAE

Bailey, 1937, I, 581.

The genus *Brunfelsia* includes about 25 spp. of shrubs, indigenous to tropical America and the West Indies. Several of them, *B. americana* Linn., *B. pauciflora* Benth., *B. hopeana* Benth. and *B. violacea* Lodd. are ornamental plants. In some of them flowers change colour as they grow old.

The drug Manaca consists of the dried roots of *B. hopeana*, a native of Brazil and the West Indies. They contain the toxic alkaloid, manacine (Wehmer, II, 1118). The drug is considered to be diuretic, alterative and antirheumatic (Wren, 224).

Brussels sprouts, see **Brassica oleracea** var. **gemmifera**.

BRYONOPSIS Arn. CUCURBITACEAE

A genus composed of 2 species of scandant herbs, one occurring in the warmer parts of Africa, Asia and Australia, the other in Norfolk Island. *B. laciniosa* (Linn.) Naud. (syn. *Bryonia laciniosa* Linn.), found throughout India, is a bitter tonic and a mild febrifuge (Kanny Lall Dey, 52). Its leaves are sometimes boiled and eaten (Duthie, I, 381).

BRYOPHYLLUM Salisb. CRASSULACEAE

A small genus of 20 species of succulent herbs, indigenous to Africa, but *B. pinnatum* has spread to all tropical countries. *Bryophyllum* is merged by some authors in the genus *Kalanchoe*.

1. BOSWELLIA SERRATA

2. BRYOPHYLLUM PINNATUM

BUTEA MONOSPERMA

B. pinnatum (Lam.) Kurz Syn. *B. calycinum* Salisb.

D. E. P., I, 543; Fl. Br. Ind., II, 413; Pl. XXXV, 2.

PERS. & HIND.—*Zakhm-haiyat*; BENG.—*Koppata*; GUJ.—*Ghayamari*; TEL.—*Sima-jamudu*.

A perennial herb, with thick fleshy leaves. It is now naturalised throughout the hot and moist parts of India and Ceylon, and is particularly common in Bengal. The plants spread by vegetative propagation, and new plants arise from the crenulations of any leaf that comes into contact with soil.

The leaves have been found to contain malic, isocitric and citric acids (Pucher, *Chem. Abstr.*, 1943, **37**, 1152; *vide* also Wehmer, I, 422; and Chopra, Ghosh and Dutt, *Indian J. med. Res.*, 1934, **22**, 268).

Slightly toasted leaves are a very good application for wounds, bruises, boils, and bites of venomous insects. Beneficial effects follow their application to contused wounds, swelling and discoloration are prevented, and the union of the cut parts takes place rapidly (Kirt. & Basu, II, 999). In the form of poultice and powder they are used for sloughing ulcers (Chopra *et al.*, *loc. cit.*).

The leaves reduced to a paste and applied daily to wounds encourage papillation. They have also proved beneficial in veterinary cases.

BUCHANANIA Spreng. ANACARDIACEAE

The genus includes 20 species of trees and shrubs, 6 of which occur in India. It is distributed in tropical Asia, Australia and the Pacific Islands.

B. angustifolia and *B. lanzan* are commercial timber trees. The barks of *B. lanzan* and *B. arborescens* Blume contain tannin. The latter is found in the Andamans and Tenasserim. Its bark contains 11·1 per cent. of tannin (Baens & West, *Philip. J. Sci.*, 1934, **55**, 177).

B. angustifolia Roxb.

Fl. Br. Ind., II, 23.

TEL.—*Pedda sara*; TAM.—*Mudamah, kolamavu*; MAL.—*Malamavu*.

A medium-sized tree, 20′ in height and 2-3′ in girth, occurring in the drier forests at low altitudes, chiefly in the Deccan Peninsula.

The nuts from the fruits are edible and are similar to those of *B. lanzan*.

The wood is white or sometimes with a faint yellowish or roseate cast, turning greyish-brown. It is rather lustrous when freshly exposed, but turns dull afterwards. It is light (sp. gr., approx. 0·59; air-dry wt., 38 lb. per c. ft.), and closely resembles the wood of *B. lanzan*. It is easy to season, but is much subject to grey-black stain (fungal), due to its unusually high starch content. Therefore it should be converted and air-seasoned promptly. It is moderately hard and strong, but not durable, and is liable to insect attacks. It is easy to saw and work, and finishes to a fairly smooth surface. It is, however, not much used. In Cuddapah, it is used for construction of temporary sheds, yokes, and sometimes for planking (Pearson and Brown, I, 328).

B. lanzan Spreng. Syn. *B. latifolia* Roxb.

D.E.P., I, 544; C.P., 188; Fl. Br. Ind., II, 23; Beddome, Pl. 165.

HIND.—*Piyar, charoli, chironji*; BENG.—*Pival, chironji*; MAR. & GUJ.—*Charoli*; TEL.—*Sara*; KAN.—*Nurkal*.

A medium-sized tree, attaining a height of 50′ and a girth of 4′, leafless only for a very short time. The dark grey bark is thick and is divided into small rectangular plates, resembling crocodile-hide The fruit is a black single-seeded drupe, ½″ in diameter.

The tree is found in dry deciduous forests throughout India and Burma; in north-western India from the Sutlej to Nepal ascending to 3,000′. Within its natural habitat it is a useful tree for covering dry hill sides.

The leaves have been reported to be used for fodder in Bombay and in the Punjab, and the bark and the fruits to furnish a natural varnish. The fruit is eaten by the hill tribes of central India.

The kernels are eaten raw or roasted and form a substitute for almonds, and are much used in the manufacture of sweetmeats. They contain: oil, 51·8; starch, 12·1; protein, 21·6; and sugars, 5% (*J. R. Soc. Arts.*, 1915-16, **64**, 788).

The light yellow oil is sweet and has a mild pleasant aroma. It is reported to be used as a substitute for olive oil and almond oil. It has the following constants: sp. gr./30°, 0·9257; n/40°, 1·46; sap. val., 193·2; iod. val., 64·4; acid val., 31 (Godbole, Gunde and Srivastava, *J. Indian chem. Soc.*, 1941, **18**, 557).

A pellucid gum, resembling *Bassora* gum, exudes from wounds on stems. It is considered efficacious in diarrhoea (Kanny Lall Dey, 53).

The bark contains 13·4 per cent. of tannins and 9·4 per cent. of non-tannins (*Bull. imp. Inst., Lond.*, 1925, **23**, 161). It yields dark reddish-brown leather of somewhat stiff and harsh texture.

The wood is light grey to greyish-brown, sometimes with a faint yellowish tinge, and in large trees there is a small amount of dark-brown heartwood The timber is frequently discoloured by a greyish-black fungal stain. It is rather rough, very light (air-dry wt., 29 lb. per c. ft.), even and straight-grained, and coarse-textured. It is featured anatomically by faintly defined growth rings, large pores with abundant paratracheal parenchyma and markedly heterogenous wood rays, horizontal gum canals in fusiform rays, and copious starch deposits (Pearson and Brown, I, 326).

It presents no difficulties in seasoning, but being extremely prone to rapid fungal attack, it should be converted soon after felling. It is moderately strong in spite of its light weight, and fairly durable if kept dry and away from white ants. It is easy to saw and works to a moderate finish. It has been used locally for boxes, bedsteads, yokes, posts, doors and cheap furniture (Pearson and Brown *loc. cit.*). It has been reported to be suitable for match manufacture (Ramaswami, 5).

The price of this wood is not high. In 1937, Bombay quoted Rs. 25–35, and Orissa Rs. 19, per ton (Trotter, 1944, 68).

BUCKLANDIA R. Br. HAMAMELIDACEAE

A monotypic genus which yields a valuable timber.

B. populnea R. Br.

D. E. P., I, 545; Fl. Br. Ind., II, 429.

BENG.—*Pipli*; NEPAL—*Pipli*; KHASIA—*Dingdah*; TRADE—Pipli.

A tall, evergreen, handsome tree, with a rough, brown bark. It often attains a height of up to 40′ and a girth of 5′.

It is met with in the Eastern Himalayas, Khasia Hills, Manipur, the hills of Martaban, and extends eastwards to South China, Malay Peninsula, Sumatra and Java. It is usually found at altitudes between 4,000–6,500′, where rainfall is about 120–160 inches.

B. populnea is one of the most valuable trees of Darjeeling Hills (Gamble, 331). It is very useful for afforestation and for the protection of hill slopes liable to landslips, and has been extensively adopted by the Indian Forest and Cinchona departments for replanting upon bared areas. Plants are raised from seedlings and transplanted when 5 years old, and above 3′ in height.

The bark contains: tannin, 11; and non-tans, 10 per cent. (Fraymouth and Pilgrim, ex *Indian For. Leafl.*, No. 72, 1944, 6).

The wood is light reddish-brown to brown or greyish-brown, smooth, moderately heavy (air-dry wt., 40 lb. per c. ft.), shallowly interlocked-grained and fine-textured. The timber is moderately strong, elastic and hard. It is not difficult to season, though liable to end-splitting, if left in the log. It should be converted when green and not allowed to season too rapidly. It is very durable under cover and fairly durable in exposed situations. It is easy to work, finishes to an exceptionally smooth surface and can take a high polish (Pearson and Brown, I, 480).

It is much used for planking, beams, door and window frames, and general carpentry. It is also used for tea chests. It should make good stained furniture (Pearson and Brown, *loc. cit.*). It has been found suitable for manufacture of plywood (Trotter, 1944, 219).

Buck-thorn, see **Rhamnus persicus**

Buck-wheat, see **Fagopyrum esculentum**

BUDDLEIA Linn. LOGANIACEAE

D. E. P., I, 546; Fl. Br. Ind., IV, 81.

A genus of approximately 90 species of herbs, shrubs, and small trees, distributed in tropical and subtropical Asia, Africa, and America.

B. asiatica Lour., *B. colvillei* Hook. f. & Thoms., *B. globosa* Hope, *B. lindleyana* Fort. and *B. madagascariensis* Lam. are ornamental garden plants. *B. asiatica* is used in the Philippines for skin complaints and as an abortifacient (Burkill, I, 379). Its root, dried and powdered, is reported to be used by the local people in Darjeeling in the preparation of a fermented liquor (*Indian med. Gaz.*, 1932, **67**, 551).

Buffaloe, see **Cattle**

BUILDING STONES

Building stones and clays are amongst the commonest mineral substances used by man. Stones have been used from prehistoric times to serve the needs of art and architecture, for building palaces, monuments, memorials, forts, bridges, etc., in some of which, decorative effect is achieved by employing polished, carved and inlaid stones. The stage of civilisation and cultural advancement of a country during any period can be gauged by the style and beauty of architecture of that age. The existence of a great variety of useful stones has in no small measure contributed to the magnificent achievements of India in the field of architecture.

GENERAL CHARACTERS OF BUILDING STONES

For small-scale buildings, it is perhaps not necessary to bestow much attention on the selection of stone. But considerable care must be exercised in the choice of suitable stones for the construction of large structures, which are designed to last for many years and to withstand great stresses. The characters, which need study are hardness, toughness, porosity, strength and durability.

The strength or 'crushing strength' of a rock is its resistance to crushing under load. This depends on the essential nature of the rock, but is affected by the freshness of minerals, degree of saturation by water, presence of fine joints and cracks, etc. Prepared cubes of the specimens are tested for crushing strength. Cracks begin to appear at about half the ultimate strength, the latter being the load under which complete failure occurs.

In the case of rocks used as slabs or beams, tests are made to determine the 'transverse strength' on pieces loaded in the middle. Gneissic rocks and laminated rocks like slates show a high transverse strength, when pressure is applied perpendicular to the plane of banding or cleavage. They are less strong in a direction parallel to the banding or cleavage.

In actual practice, the stresses encountered scarcely exceed a tenth of the ultimate strength determined in the laboratory, so that a large margin of safety is left. For most purposes, a crushing strength of over 400–500 tons per sq. foot should be considered satisfactory.

Numerous varieties of rocks are used for building purposes. These may be classified according to their origin into: (1) *igneous rocks*, which have crystallised out from a molten condition, (2) *sedimentary rocks*, formed by the deposition of detrital matter in water, or by the precipitation of dissolved substances, or by the accumulation of the remains of organisms, and (3) *metamorphic rocks*, consisting of rocks transformed into new types by the effects of pressure, temperature and magmatic solutions.

Igneous rocks: **Granites** are igneous rocks composed of quartz, alkali felspar, mica and a few minor minerals. They are the most common plutonic igneous rocks, exposed on the surface. The texture is granitoid (granular) but grain size may vary from fine to coarse; and porphyritic crystals of felspar may also be present. The colour depends on those of felspar and ferromagnesian minerals present, and may vary from white to light grey, bluish-grey or pink.

The specific gravity is about 2·65–2·7 (160–165 lb. per c. ft.), while the crushing strength ranges from 800–1,200 tons per sq. ft. The medium-grained varieties are stronger than coarse or fine-grained varieties.

Granites are liable to crack and spall off, when heated strongly and suddenly quenched in water. This may be due partly to unequal expansion of quartz and felspar, and partly to expansion of gaseous inclusions that may be present in quartz.

Large blocks of granite can generally be obtained from the quarries. Boulders of large dimensions are a common feature of areas occupied by granite and granite-gneiss. Because of this, granite is perhaps the most popular building stone used in massive structures like forts, bridge piers, dams, and protective walls.

Syenites and **Diorites** may or may not contain quartz but have a high proportion of felspar and some hornblende. Specific gravity varies from about 2·7 in syenites (170 lb. per c. ft.) to 2·85 in diorites (180 lb. per c. ft.), and crushing strength from 800–1,400 tons per sq. ft. Ordinary syenites and diorites are quite durable, but nepheline syenites are liable to weather easily.

Gabbros consist of basic felspar and pyroxene, with or without olivine. They are dark-coloured, but take good polish. Specific gravity is about 3·0 (*ca.* 185 lb. per c. ft.), and crushing strength, somewhat inferior to that of granite.

ULTRABASIC ROCKS (SiO_2, <45%) including the dunites, peridotites, pyroxenites, etc. are not common and occur only as small and unimportant bodies. They are comparatively easily weathered and may be found altered to serpentine, talc or chlorite. Their specific gravity varies from to 3·0–3·3 (185-200 lb. per c. ft.). Some varieties are occasionally used for decorative purposes.

HYPABYSSAL (dyke) and VOLCANIC (dyke and volcanic) ROCKS : The finer grained representatives of plutonic types comprise rhyolites and porphyry (acid, –SiO_2, 55–70%), trachyte and andesite (intermediate,—SiO_2,< 55–70%), dolorite and basalt (basic,—SiO_2, <45-55%). Basic types are the most common and are widely used. Dolerites and basalts are hard and tough rocks of dark colour (sp. gr., *ca.* 3·0; wt., 185 lb. per c. ft.), and crushing strength equalling that of good granite. They are not obtainable in large sizes because jointing is closer than in granite. But they are excellent stones for general construction and for road making.

Sedimentary rocks : SANDSTONES (Pl. XXXVII, 1) consist of sand, cemented by silica, iron, lime, etc. The degree of compaction, and the strength of the cementing medium determine the strength of the stone. Their specific gravity varies from 2·65 in highly siliceous stones to 2·95 in those containing ferruginous matter. Medium-grained, hard, compact sandstone has a crushing strength of 600 tons per sq. ft. but quartzitic stones are even stronger.

The colour of sandstones depends on the cementing material : ferruginous sandstones are red to brown ; argillaceous, earthy to buff ; siliceous, generally white ; carbonaceous, black. Ferruginous sandstones of yellow or greenish tint may change colour on exposure, because of oxidation. Siliceous cement generally makes the stones strong but difficult to work, while argillaceous cement tends to make them weak. Calcareous cement is liable to chemical attack.

The porosity of sandstone varies much, from less than 1% to as much as 15 per cent. Well-cemented sandstones with angular and graded grains are very compact and strong. Those with high porosity are not suitable for building purposes.

Sandstones may yield large blocks which are easily dressed into small rectangular pieces, or comparatively thin flags. The type of material will depend on the spacing of bedding planes and of joints.

SHALES : When muds and clays are compacted, they become shales which may still contain 3–5% pore space. Shales can be split into fairly thin slabs, parallel to bedding planes, but the planes are not as regular as in good slates. Being soft, shales are not useful as building stones.

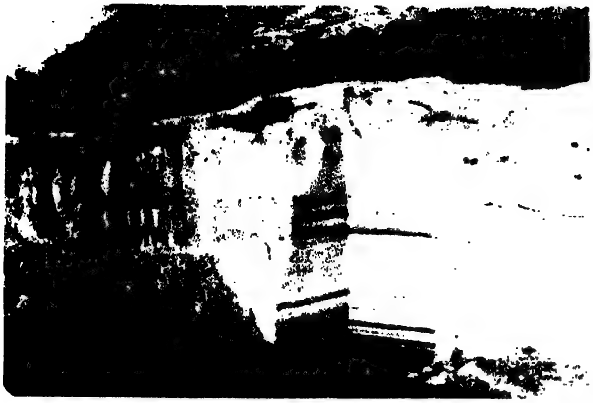
LIMESTONES (AND DOLOMITES) : The different type of limestone met with are chalk, lithographic stone, oölitic, nodular, brecciated and organic limestones (coral, crinoidal, shell or foraminiferal). According to the nature of the development of bedding planes, limestones may be massive or thin-bedded (Pl. XXXVII, 3).

The physical properties of limestones vary greatly. Porosity is small in compact hard limestones, and large in soft friable varieties. Fossiliferous limestones are often coarse and porous. Hardness depends on compaction and the nature of cement ; siliceous limestones are harder than other varieties.

Massive, dense and fine-grained varieties are generally durable, if they do not contain deleterious constituents. The presence of other minerals encourages uneven weathering, the chemically resistant ones like quartz or silicates, standing out prominently among the carbonate grains. Chert veins and nodules and segregations of iron oxides are made prominent by differential weathering. They are also disadvantageous for planing and polishing the surface. The specific gravity of limestones is about 2·175) 170 lb. per c.ft.) ; while crushing strength ranges up to 500 tons per sq. ft.

ONYX MARBLE is a banded calcareous rock, deposited from solution in caves and hollows, or by hot springs. The material is comparatively rare but if available, banded varieties are used as ornamental stones.

Metamorphic rocks : GNEISSES and SCHISTS are derived from various types of materials, both igneous and sedimentary. The common types are granitic, hornblendic and garnetiferous gneisses. They generally show a banded structure and are as strong and durable as granite. Some gneisses have good transverse strength and are used for beams and posts.



1. SANDSTONE CLIFFS

SOAPSTONE

3. LIMESTONE QUARRY

4. MARBLE QUARRY

Basic igneous rocks like dolerites and basalts are often metamorphosed to a hard, tough rock, called epidiorite. This material can be used for structural purposes and as road metal. In strength and durability it is equal, if not superior, to the parent basic rock.

Schistose rocks are characterised by fine foliation or lamination developed by shearing stresses during metamorphism. Their minerals are platy or micaceous, and lie with their flat faces parallel to the plane of schistosity, along which the rocks split easily into thin slabs. Quartz-schists, micaceous quartz-schists and hornblende-quartz-schists can be used as paving stones, but not the softer varieties like mica-, chlorite-, and talc-schists.

Slates: The metamorphism or shales by pressure produces slates, which are characterised by the presence of close-set planes or cleavage, along which they can be easily split into thin sheets. Those with good and even cleavage are valued most, and are used as roofing slates and school slates. The planes of cleavage are related solely to the direction of pressure to which the material was subjected, and not to the bedding plane. The latter are seen as bands and ribbons on the cleavage face.

The usual colours of slates are black, dark-grey, greenish-grey and purplish-grey. In some cases, colour may change on weathering. Slates are of varying degrees of hardness, the harder ones being sometimes used for flooring. The transverse strength of good hard slates is high.

Slates containing deleterious minerals (pyrite or free coarse calcite) are not durable and should not be used for exterior work. Micaceous and chloritic slates are generally of good quality.

Crystalline limestone or marble (Pl. XXXVII, 4): Metamorphosed limestones and dolomites become recrystallised and may show banded and brecciated structure. A large variety of colours may be seen —white, opales-cent, grey, black, pink, red, brown, yellow, green, blue, or a combination of these. The colours may appear in bands, patches, streaks and smears, contributing a great deal to the beauty of the stone.

The chief mineral is calcite (or dolomite), but impure varieties have varying amounts of quartz, mica, tremolite, diopside or other silicates. Marbles with appreciable quantities of such minerals weather unevenly in exposed places, because silicates are more resistant to weathering than carbonates.

Impure marbles may appear more beautiful, but the most durable varieties are those which are nearly pure carbonate rocks, with medium grain and uniform texture. The presence of minerals of varying hardness makes the polishing of marble rather difficult.

With increasing quantities of impurities and silicate minerals, marbles become calciphyres, calc-gneisses and calc-granulites. Some of the latter are practically devoid of carbonates. These rocks are not abundant, and may be used to a very limited extent as building stones.

Serpentine marble derived from dolomitic rock is composed of serpentine and carbonate. Deposits of such materials are worked for ornamental stones but they do not yield large pieces because of irregular jointing. Serpentine marble is generally coloured in shades of yellow and green, though red and brown colours may also be present here and there. They are not durable in exterior situations.

Soapstone (Pl. XXXVII, 2) also called talc-schist or steatite, is composed largely of talc, together with varying quantities of other minerals like amphiboles, quartz, iron ore grains, etc. It is mainly of a light grey or greenish colour, but pink and green varieties are also known. Steatite is fairly resistant to weather, but is easily worn out because of its softness.

Being soft and easy to work, it is used for carving ornamental objects and images and also for making tubs and cisterns, household utensils, laboratory sinks, acid tanks, table-tops, furnace-lining blocks, windows, etc. High quality steatite, of uniform texture and free from deleterious impurities, is used in electrical insulation and for decorative purposes.

STONE DECAY AND PRESERVATION

The weathering and decay of stones depend on several factors. These include erosion by wind, armed with sand particles; expansion and contraction due to daily and seasonal temperature changes, resulting in disintegration; freezing and thawing of the moisture, contained in pore spaces; and the chemical action of atmospheric gases and water.

Homogeneous and uniform-grained stones weather evenly. Stones with marked difference in the size of component minerals and thin-bedded stones are liable to show irregular weathering. If the matrix and cementing substance are different, as in some types of sandstone, the two may be attacked at different rates ; this is especially true of calcareous sandstones in which the calcareous cement is readily dissolved by carbonated water. Limestones also generally wear irregularly, with a pitted surface. Pyrite in a stone is sooner or later decomposed into ferric hydroxide and sulphuric acid, the former producing a brown stain, and the latter giving rise to efflorescence of calcium or magnesium sulphate.

Porous stones should not be used for external work, where they are liable to repeated soaking and drying. They may also absorb salts from the soil which effloresce later and appear behind the plaster at or above ground level. The soil salts include chlorides, sulphates and nitrates.

Efflorescences may appear on porous stones. If they can be washed off by water without damage, this must be tried. Dirty stone may be washed with soap, but caustic alkali should not be used, as it may induce chemical action. After washing and drying, a preservative may be applied to the stone but it must be such as will not have any action on it. An ideal preservative should fill the pores of the stone, and not merely form a crust or film on the surface. The preservative should allow escape of moisture from the stone, but should not absorb atmospheric moisture.

Preservatives and coatings which have been used are water-glass, fluosilicate, plaster and paint. In some cases, a coat of oil-paint is satisfactory.

DISTRIBUTION
(LaTouche, 26–62)

Andaman Islands: Limestones (of Tertiary age ?) occurring at South Corbyn near Port Blair (11° 41′ : 92° 43′) have been quarried and used in that town. The stone is fine-grained, but veined with calcite, which makes it rather liable to break.

There are some deposits of serpentine near Port Blair, capable of being used as ornamental stones.

Assam: Granites and gneisses are found in the northern parts of the Khasi and Jaintia hills, but they have not been used to any extent.

The Cherra sandstone (Cretaceous-Eocene) exposed on the Cherrapunji plateau is a grey to buff rock, suitable for building purposes.

Nummulitic limestones are found on the southern scarps of the Assam plateau. They are worked and transported to the Surma valley, and to different parts of Bengal, for building purposes and for lime-burning. Some limestones suitable for ornamental purposes occur in Lakhimpur dist. between the Dihang river and Brahmakund.

The slates known in the valleys of the Tuzu and Tepo rivers in the Naga hills region are of good quality. They are locally used for roofing.

Baluchistan : This province possesses inexhaustible reserves of limestones, which are of various ages, from the Jurassic to the Miocene. Some of these should be excellent for building purposes. Lack of transport facilities and distance to markets are the main obstacles to the development of the deposits, though at Quetta, a Cretaceous limestone is used to a limited extent.

Baroda State (Foote and Shah) : Granites and gneisses, some of high decorative value, are found near Virpur (23°45′ : 72°51′), Bhulvan (22°13′ : 73°39′), Bhadrali (22°14′ : 73°41′) and other places.

Basalt is quarried at Amreli (21°36′ : 71°16′) and other places, while felsites and acidic traps occur at Barda (21°50′ : 69°50′), Alech (21°50′ : 70°0′), and Damnagar (21°42′ : 71°35′). They are suitable for general construction.

A hard, red and white, siliceous breccia which can be split into thick slabs is found at Sandia (22°6′ : 73°44′), while excellent sandstones of different colours and texture are quarried at Songir (22°6′ : 73°41′). Flaggy quartzites are available at Achali (22°19′ : 73°41′) and other places, while slates of fair quality occur at Surajpur (22°26′ : 73°41′).

Excellent limestones, some of which are brecciated in structure and suitable for ornamental work, are found at Sandara (22°4′ : 73°39′). The best-known marbles of Baroda are those quarried at Motipura near Bhulvan. They are green, white and pink, but brown and cream coloured varieties also occur. Material similar to the Porbandar stone (militolite) is also quarried in Baroda territory in Kathiawar and used locally.

Bengal : Quartzites, presumably of Archaean age, occur in the Susunia hill (23°24′ : 87°3′) in Bankura

dist. These were formerly much used in Calcutta for paving floors.

Gneissic rocks are extensively developed in Darjeeling and Midnapore dists. Dolomites and slaty rocks are found in sub-Himalayan areas (Daling and Buxa series), but they are not so much used as gneisses.

Though Siwalik sandstones are largely developed in the Himalayan foot-hills, they are to be carefully selected for use as building stones. Tertiary (Miocene ?) sandstones and laterite are found in Midnapore and used locally. The Gondwana (Raniganj) sandstones of Burdwan dist. are generally not of good quality, but find some use locally.

Bihar: In many dists. south of the Ganges, granites and gneisses are available comprising the varieties known as Chota Nagpur gneiss, Domo gneiss and Singhbhum granite.

The dolerites, Rajmahal traps, and epidiorites are used extensively as road metal, and to a limited extent for building purposes.

Sandstones of the iron-ore series and of the Kolhan series are worked near Chaibasa and Galudih and used locally. Similar rocks are worked also in Monghyr and Gaya districts.

Gondwana sandstones are found in the coalfields and in Santal Parganas, some of the varieties being useful for building, and some as grindstones. Vindhyan sandstones (Kaimur series) of good quality are quarried in Shahbad dist. They are creamy to pink or light buff, durable, and easily dressed and shaped.

Limestones are found in the Lower Vindhyans of the Son valley. They are now-a-days used more for lime and cement making than for building purposes. Some limestones occur in Palamau dist. near Chlerpat (23°50′ : 84°48′) on the Maila river and at Baghmara (23°39′ : 86°48′) at the western end of the Raniganj coalfield. The latter is partly dolomitic and has been used as a flux. A few miles further west, crystalline limestones are found at Hansapathar (23°38′: 86°43′); the exposure is over 2 miles long and about 100′ thick.

Slates of good quality have been worked in the Kharakpur hills near Jamalpur in Monghyr dist. and used for floors and ceilings. Some slate is also quarried near Bhitar Dari (22°41′ : 86°11′) in Singhbhum.

Amongst the less common stones, suitable for ornamental work are rose quartz in the pegmatites of the mica belt, e.g. in the mines near Parsabad railway station; epidote-rock occurring near Dasauri (22°56′ : 85°37′), Rugudih (22°53′ : 85°39′), Jato (22°55′ : 85°16′) and Sekradih (22°54′: 85°50′) in Ranchi and Singhbhum; the banded haematite jaspers of Dhalbhum; and soapstone in several places along the northern border of Singhbhum, along parts of the copper belt and amongst the chromite-bearing ultrabasic rocks in Singhbhum.

Bombay: The most abundant and commonly used rocks of this Province are from the Deccan Trap formation, which yields both dolerite-basalt (dark trap) and trachyte (white trap). The dolerite (or basalt) is dark-grey with greenish or brownish tinge and generally fine-grained, though porphyritic varieties are occasionally found. Because of close and irregular jointing, large blocks are unobtainable, but the stone is hard, tough and durable.

A greyish-white trachytic trap is known to occur in the Karia hill (21°14′ : 73°20′) and in the Bardaria hill near Undi (21°40′ : 73°23′). A creamy to light-yellow trachyte from the same formation is extensively quarried near Bombay (Kurla trap). It is a good stone, but occasionally it contains pyrite which gives rise to brown stains on exposure. The rock also contains a little calcite which is liable to form calcium sulphate in combination with sulphur, derived from the city atmosphere, or from adjacent grains of pyrite. Cowasjee (*Prof. pap., Indian Engng., Roorkee*, 1871, Ser. 2, **1**, No. 2) has given comparative tests on building stones used in Bombay while Hallowes has dealt with stones found in the Salsette Island, in Geology of the Island of Salsette (1922).

Granitic gneisses of good quality are won from near Khanapur (15°38′ : 74°34′) south of Belgaum. Pink and greenish varieties of similar rocks are found near Bilgi (16°21′ : 75°41′).

Hornblendic and chloritic quartz schists, and even hematitic schists of the Dharwar system are quarried in Dharwar and Kanara dists.

Well-cleaved slates and phyllites, found in certain parts of the Aravalli system in Jambughoda State and Jhalod in Panch Mahals are quarried and used locally as flooring and roofing materials. Some slaty shales won at Sillikeri (16°9′ : 75°35′), Lokapur (16°10′ : 75°26′), and Talikota (16°28′ : 76°22′) are

used locally for roofing and building. These are said to be merely hard shales and not true slates. Flagstones of good quality are won at Haligeri (16°0′ : 75°32′) in Bijapur dist.

Good massive sandstones of the Bagh beds exposed along the valley of the Deve river, and hard quartzitic sandstones of Sakva (21°51′ : 75°41′) are employed locally. Excellent yellow and brown sandstones are quarried at Aiholi (16°1′ : 75°57′) in Bijapur dist. Sandstones are also worked at Parvat (16°2′ : 75°51′) and Alkopur (16°28′ : 76°6′). Excellent freestone is furnished by quarries in Ahmednagar sandstones (Upper Gondwana) near Ahmednagar in Idar State. Hard gritty sandstones of Infratrappean age are quarried at Nathkua (22°26′: 73°35′) in Panch Mahals and near Vajiria (22°2′ : 73°27′) in Rewa Kantha. They are used as building stones and grindstones. The Nathkua material has been extensively used in the ancient city of Champaner.

The Kaladgi series near Kaladgi (16°12′ : 75°31′) yields limestones of different colours—pink, purple, green, grey and black, whereas the Bhima series yields grey, drab, and cream coloured stones near Uguni (16°34′ : 76°32′) and other places. Crystalline limestones and marbles are available in several places in Idar State.

Burma : Granites and gneisses are found mostly in rather inaccessible areas. A hornblende granite is used at Pyinyaung (20°47′ : 96°26′) in Meiktila dist. for public works. The Kabaing granite of the Mogok tract is a good medium-grained stone, which is becoming popular locally. Granitoid gneiss is quarried at the base of the Shan scarp, east of the Sittang river in Thaton. It is transported to some of the towns including Rangoon. The Kalagauk Island also yields similar stone.

Basalt is quarried in the Shahyindaung hill three miles north of Alon (22°15′ : 95°5′) in Lower Chindwin dist.

Sandstones are extensively developed in populous areas and are used locally. Yellow and purple sandstones are quarried at Toungoo (18°55′ : 96°28′), yellow varieties being abundant as they form beds over 200′ thick, while purple varieties, though harder are only a few inches thick. Hard sandstones are worked on the Shwebo-Kyaungmaung road and used for public works and general building purposes.

The Jurassic Namyau series yield good sandstones in the eastern parts of the Shan Plateau, where stones, quarried near Hsipaw (22°37′ : 97°20′), have been employed in building the bridge over the Namtu river, and other structures.

Tertiary sandstones, mostly of Pegu age, are available in several places. A good freestone is quarried at Tangu (21°42′ : 95°3′) in Pakokku dist., and used extensively for flooring and general building. There are also quarries in Lower Chindwin dist. producing similar freestones.

Limestones occur in several districts. A calcareous slate quarried near Kyaukse (21°37′ : 96°10′) in the district of the same name, is used for paving floors. The Moulmein limestone of Amherst dist. is of good quality, but the presence of thin veins of calcite renders it brittle. A chocolate-coloured limestone is quarried at Zebingyi (21°53′ : 96°21′) in Mandalay dist., and used in several places including Rangoon. Good limestones are found at Thamandewa (16°23′ : 94°42′) and Banuri (17°19′ : 94°41′), in Bassein. There are several occurrences on the eastern coast of Ramri Island, the most important of which is at Yanthak (19°8′ : 93°56′). Nummulitic limestones are found along the eastern foot of the Arakan Yomas near Thayetmyo (19°19′ : 95°14′), but they are used more for lime-making than for building purposes.

An excellent white marble, much used as ornamental stone and for carving, is quarried in the Sagyin hills (22°17′ : 96°7′). It is particularly favoured for making images of Buddha and for pierced screens. A similar marble is found at Kyaukse (21°37′ : 96°11′) extending probably into the Mogok tract. It is in places interbanded with grey stone and is not used to the same extent as the Sagyin stone for artistic work.

A fossiliferous limestone at Padaukpin (22°6′ : 96°40′) near Wetwin railway station is a fine ornamental stone when polished. Some of the Permo-Carboniferous limestones of the Northern Shan States are good for decorative work, but they are at present away from lines of communication. Some limestones and serpentines are available in the Jade Mines tract.

Central India : The Central India Agency is occupied mostly by Vindhyan and Deccan Trap formations. The Vindhyans are capable of yielding inexhaustible quantities of excellent sandstone.

The Kaimur series contains good white, pale-red or buff stones, of massive or flaggy character, while stones from the Bhander series are usually somewhat more gritty, and red or brown in colour. But the latter also yield some excellent varieties.

Gondwana sandstones of good quality occur near Barwai and Katkut (22°25′ : 76°10′) in Indore State. The Barakar sandstones occurring at Kirintal and Amha (23°29′ : 80°57′) in Rewah State are said to be very good for building purposes.

Limestones of Archaean, Bijawar and Lameta ages are available in Rewah State. The limestone from Sutna (24°34′ : 80°53′) is much used for lime-making and to a limited extent for building. A coralline limestone from the Bagh beds at Kherwan and Chirakhan (22°23′ : 75°11′) is a fine ornamental marble used locally.

Fairly good slates occur in the Bijawar series near Bagh (22°21′ : 74°51′) in Gwalior State.

Central Provinces (*Rec. geol. Surv. India*, 1939, **74**, 395) : Fine gneissic granites occur near Jubbulpore and between that town and Gondia. Porphyritic varieties of these are available in Drug dist. Schistose rocks yielding flagstones suitable for paving are seen in the Chilpi Ghats, though not at present used to any extent. The Ambagarh range in Bhandara dist. shows good bedded quartzites, which have been used in the construction of the forts at Ramtek and Ambagarh.

The Deccan Traps are quarried near Nagpur and other places and used for structural and road-making purposes.

Good massive sandstones of Gondwana age occur at Ellichpur (22°15′: 77°35′), in the Bhutara hill and at Isapur in Chanda, at Silewada near Kamptee, and at Nimar. The Isapur stone is pink and fine-grained and particularly suited for fine carving. White sandstones are quarried at Sirgora and Pathe in Betul dist. and grey and buff stones, near Pachmarhi. The coarse sandstones of Chirakhan (22°26′: 76°56′) in Hoshangabad dist. have been used in the construction of forts and temples. A Vindhyan (Rewah group) sandstone, won near Hoshangabad (22°45′ : 77°47′), is thin-bedded and used for roofing in that dist. The Chandarpur sandstone of Raipur dist. also contains good material in some places.

Limestones are also of wide distribution. The Bijawar limestones found near Khudia (22°14′: 76°47′) are of fair quality, but the presence of siliceous bands imparts an irregular quality to them. The Raipur limestones of Raipur dist. are much used locally, a blue-grey stone from Sikosa in Drug dist. being favoured for paving. A good limestone (of Penganga age) is quarried for building purposes at Kandara (20°18′ : 79°3′) in Chanda dist. A serviceable ragstone is furnished by the Lameta limestone immediately underlying the Deccan Traps in Nagpur and other districts. It has been used in building bridges on the Nagpur-Chhindwara branch of the railway.

Some excellent marbles are found in this province. The celebrated 'marble rocks' near Jubbulpore can yield almost unlimited quantities of fine marble. White marbles are found in Betul dist., and pink ones in Narsinghpur dist. Serpentine marbles can be got from near Devi in Chhindwara dist.

Cutch and Kathiawar : The lower portions of the Jurassic strata in Cutch yield good sandstones which are extensively worked. These are generally much better in quality than Tertiary sandstones found in the same territory.

A light-coloured sandstone (of upper Jurassic age ?) quarried near Dhrangadhra (23°0′ : 71°32′) is valuable building stone in Kathiawar. A fine-grained sandstone quarried at Baoli (22°56′ : 71°28′) is used for fine carvings and ornamental objects.

A shell limestone of yellow to red colour, locally known as Dokawana marble, takes a good polish and is used for ornamental purposes. Grey, black and orange limestones are available from the Jurassic strata near Bhuj (23°15′ : 69°44′) and in the Raimalru hill near Kaora (23°50′ : 59°45′) in the Patcham island.

A fine-grained fossiliferous limestone is found at and near Pindara (22°15′ : 69°19′) in Nawanagar. It is orange-yellow in colour and becomes red on exposure to weather. A dolomitic variety occurs near Gurgat (22°12′ : 69°15′). Some nummulitic limestones found near Tarkeshwar near Surat can be used as a building stone, perhaps to a limited extent. A good shell limestone is seen near Bardia (32°12′ : 69°5′). It can be used as a decorative stone.

A mottled marble, capable of taking good polish, occurs as a bed of some 30″ thickness amidst the trap rocks at Khirasra (21°57′: 70°22′) and Sajriala (21°56′ : 70°37′), but the quantity available appears to be limited.

A well known building stone of Kathiawar is the Porbandar stone, quarried at the base of the Barda hills. It is a calcareous sandstone, composed largely of foraminiferal shells and some clayey and sandy material. It is buff to white in colour, porous and of oolitic structure. Similar stone is found in Nawanagar and Baroda States.

Delhi : The historic 'Ridge' of Delhi forms the most northerly prolongation of the Alwar series of Rajputana. It is mostly composed of quartzite, which near Delhi is more thickly bedded and darker than the usual Alwar quartzite. The Delhi quartzite is quite vitreous and usually coarsely crystalline. It is too hard to chisel, but it is now being extensively quarried for building purposes, and for road metal.

Eastern States : Large areas of these States are covered by granites, gneisses and khondalites, which are worked only to a very limited extent for local use. The equivalents of Chota Nagpur gneiss and Singhbhum granite are found in Keonjhar, Bonai, Pal Lahara, Gangpur and other states, while the khondalites are common in the states of the Eastern Ghats. Quartzites and quartz-schists, which are flaggy, are used for paving. Slaty phyllites (e.g. in Gangpur) are employed in building, and especially for constructing walls and fences.

Crystalline limestones and dolomites are found in various places (e.g. Gangpur, Bastar, Raigarh, and in the Eastern Ghats). Some of these are of attractive grey, blue-grey and pink colour (sometimes also banded), and can take good polish for use as ornamental stones. The occurrences are, however, distant from markets, and lack transport facilities.

Hyderabad State (Mirza, *Hyderabad geol. Surv. Bull.*, No. 2, 1943, 94): Granites and gneisses are extensively developed in this state, especially in the Raichur, Manvi, and Deodurg areas. Huge stones and pillars, over 30′ in length, have been won from some of the quarries. Similar stones are also quarried near Hyderabad and Mudgal. In parts of Raichur dist., good banded gneisses, pink syenitic rocks, and dark-greenish-grey epidiorites are available. The red porphyritic gneiss of Jaldurg (16°15′ : 76°29′), the pale grey gneiss of the vicinity of Gobur (16° 19′: 77° 13′), the handsome epidote-bearing granite-gneiss of Kumunur (16° 37′ : 77° 14′) and Gagulu (16° 28′ : 77° 13′), and the red syenite of Mosulkal (16° 23′ : 77° 4′) are all stones of great decorative value. The granites and gneisses have high crushing strength.

Sandstones of good quality belonging to the Kaladgi series are quarried on a fairly large scale at Hanamsagar (15° 52′ : 76° 6′) in Raichur dist. Some of these can be delicately carved. Gondwana sandstones of Barakar and Kamthi series are quarried at Chinnur and Rajura taluks in Asifabad dist.

Slaty shales, occurring near Wazirabad in Nalgonda dist., are suitable for use as flooring and roofing stones. Slaty rocks occur also near Yadagiri and Jawargi in Gulbarga dist. and in the Yellandu area of Warangal.

There are a few belts of limestone in the State. The first is the Palnad limestone along the southern boundary of the state, which includes both massive and flaggy varieties of good colour and appearance. The second belt comprises the limestones of the Bhima series in Gulbarga dist. This group contains flaggy limestones ('Shahabad slabs' similar to 'Cuddapah slabs' of Madras), massive limestones as well as lithographic stones as at Rajan Kollur. This belt also supplies limestone to the cement works at Shahabad. The third belt comprises the Wardha and Penganga valleys, which contain ordinary as well as decorative stones.

Stones of considerable decorative value include the black limestone of Surapur taluk ; the yellow limestone from Nalwar, Gulbarga dist., and from Seram and Chincholi areas in Asifabad dist. ; a thin-bedded red stone from Farukhabad in Mahbubnagar dist. ; a brown-coloured stone from near Adilabad ; and variegated types from Wazirabad in Nalgonda dist.

Crystalline limestones (Archaean) are quarried at Yellandu and Manditog in Warangal dist. They include white, grey, black and yellow varieties, suitable both for general construction and for decorative work,

Kashmir: Granites and crystalline rocks are found chiefly along the axis of the main Himalayan range but this region is far away from populous centres.

The Panjal traps, mainly of basic composition, yield fairly good materials for construction. They are exposed over large areas in the Pir Panjal and in the Kashmir valley.

Although slaty rocks are found both in the Salkhala series and in the Dogra Slates, they are generally not of good quality.

There are good limestones of Pre-Cambrian, Carboniferous, Permian and Triassic ages, some of which are capable of yielding stones for decorative use.

Madras (Swaminathan, *Trans. Min. geol. Inst. India*, 1930, **25**, 109): Granites, gneisses and charnockites occurring in Madras are amongst the best stones available. Comparatively large slabs of granite are still detached from out-crops by the method of fire-setting. A fire is lit and gradually moved over the required area, when it causes a layer to expand and separate from the mass below. Blocks as large as 2,000 sq. feet in area have been obtained by this process.

Granites and gneisses are obtainable from practically all the districts. Grey granite and porphyry are obtainable in several places in Bellary dist., and the ruins of Vijayanagar, at Hampi near Hospet, show an instructive example of local stones used. Some quartzites and ribbon jaspers are also available in this district. Good granites and gneisses are quarried, generally on a small scale, in Nellore, Chingleput, North Arcot, Trichinopoly, Salem, Coimbatore, Madura and Tinnevelly. Some fine red or red and grey varieties are found in Madura and Tinnevelly dists., e.g. Anamalai near Madura, Aruppukkottai (9°35′ : 78°9′), Tiruparaikundram (9°53′ : 78°8′), and other places.

The garnetiferous gneiss, known as khondalite, is common in Vizagapatam, Godavari, and Kistna dists. It is not as durable or as strong as granite or granite-gneiss, but is a useful rock for ordinary purposes. It has been used in buildings in Vizagapatam, Bezwada, and other places.

The charnockites, also called 'blue granites', are amongst the most durable stones of India. They are found in the Eastern Ghats of Vizagapatam, Godavari and Kistna, and in Guntur, Nellore, Chingleput (St. Thomas' Mount and Pallavaram), North and South Arcot, Trichinopoly, Salem, Coimbatore, Nilgiris, Palnis, Anamalais, Shevaroys, etc. The famous Seven Pagodas at Mahabalipuram near Madras are cut out of charnockites, and numerous temples, forts and other buildings have been built of them. The charnockites are generally massive-looking, but in some places (e.g. Shevaroys and Nilgiris) they show banding on weathered surfaces. As they possess high strength and durability, they are particularly well-suited for heavy structural work.

Crystalline limestones occur in Tinnevelly, Coimbatore, Trichinopoly, Salem and other districts but they have not been used to any extent, though containing bands, suitable for building and ornamental purposes.

White, black, coloured and variegated limestones are available from the Narji limestone belt, especially in the Palnad tract of Guntur, where some exceedingly handsome varieties are available. The Vempalle limestones of the Cuddapah basin can yield stone for building purposes. Some lithographic limestones also occur in Kurnool dist. Amongst the Cretaceous rocks of Trichinopoly are a grey limestone, used locally for building and for cement manufacture, and a shell limestone of high decorative value. Recent coral-limestone is quarried along the Ramnad and Tinnevelly coasts, and used for building and lime manufacture.

Calcareous slates, which form excellent flagstones, are developed in the Jammalmadugu stage of the Kurnool series, which are quarried near Yerraguntla, Jammalmadugu (Cuddapah dist.) and Betamcherla (Kurnool dist.). These yield slabs, 0·5-5″ thick and up to 10–12′ long and 4–5′ wide. They are widely used throughout the province for flooring and for paving courtyards, and are commonly known as 'Cuddapah slabs'.

Good sandstones and quartzites are not common in this province. A sandstone of the Pulivendla stage is quarried near a place of the same name for local use, while a fine-grained stone of the Nallamalai series is quarried at Sirigepalle in the Jammalmadugu area. Upper Gondwana and Cuddalore sandstones occasionally yield stones of fair quality and are used to a small extent in Godavari, Kistna, Guntur and Chingleput districts. A sub-recent calcareous sandstone of the

coastal region of Ramnad and Tinnevelly has also been used for building purposes.

Good slates as well as clay slates are quarried at Markapur on the border of Kurnool and Nellore districts. They are used for flooring, roofing and for school slates.

Thin local deposits of laterite are available in most districts. Thick formations of this rock are found especially along the western coast in Malabar and South Kanara districts, where it is extensively used.

Mysore: Granites and gneisses are widely distributed in Mysore State (Pl. XXXVIII). Important amongst these are the pink granite of Chitaldrug, the grey and pink granite of Closepet and Channapatna, and the banded gneisses of Bangalore and Kolar. A handsome red porphyry occurs near Seringapatam. Similar porphyries are available also near Tadugavadi (12° 27′: 76° 53′); Sidlingapur (12° 22′ : 76° 42′) and other places in Mysore dist. There is a flourishing trade in kerb-stones in Bangalore and Kolar districts.

Some amphibolites occurring near Kadehalli in Tumkur dist. and near Chennarayapatna in Hassan dist. have been used in Mysore city for building purposes.

A beautiful bright green quartzite (fuchsite quartzite) occurs in the neighbourhood of Belvadi (13° 17′: 76° 3′) in Hassan dist. It is a stone of high decorative value when polished.

Finely laminated slaty schists and chloritic schists are quarried in Chitaldrug dist. Good slabs of the latter are got from the quarries at Jagalur. Slaty flags, similar to 'Cuddapah slabs', are quarried at Yerradkatte and Metakurike near Hiriyur, Chitaldrug dist.

North-West Frontier Province (Coulson, *Rec. geol. Surv. India*, 1940, **75**, *Prof. paper*, No. 2, 15): Good banded gneissic granites occur in the north-western parts of the province. They are used locally in the form of rather thick slabs. There are also some schistose rocks, which yield flags about one inch thick. The Attock slates are quarried at several places in Peshawar dist., and used for flooring, lining canals, etc., but they are not of good quality.

Limestones of Triassic age are quarried near Abbottabad (34° 9′: 73° 16′) and Hasan Abdul (33° 50′ : 72° 45′). They are dark-grey, and quite useful as building stones. Ordinary limestones are also available at Ghundai Tarako in Mardan dist., and in Kohat and Dehra Ismail Khan dists.

Some very good marbles are available in this province. The white marbles of Shahidmena (34° 9′ : 71° 7′) and Ghundai Tarako (34° 13′ : 72° 25′) are good stones for decoration and for statuary. The banded marbles of Lowaramena (34° 8′: 71° 19′) are useful for general building, while the marbles and serpentines of Maneri (34°8′ : 72°28′) in the Swabi tahsil can be used for decorative work. Excellent white marbles are found also a little south of Buta Kundi on the banks of the Doddur, tributary of the Kunhar river in Hazara.

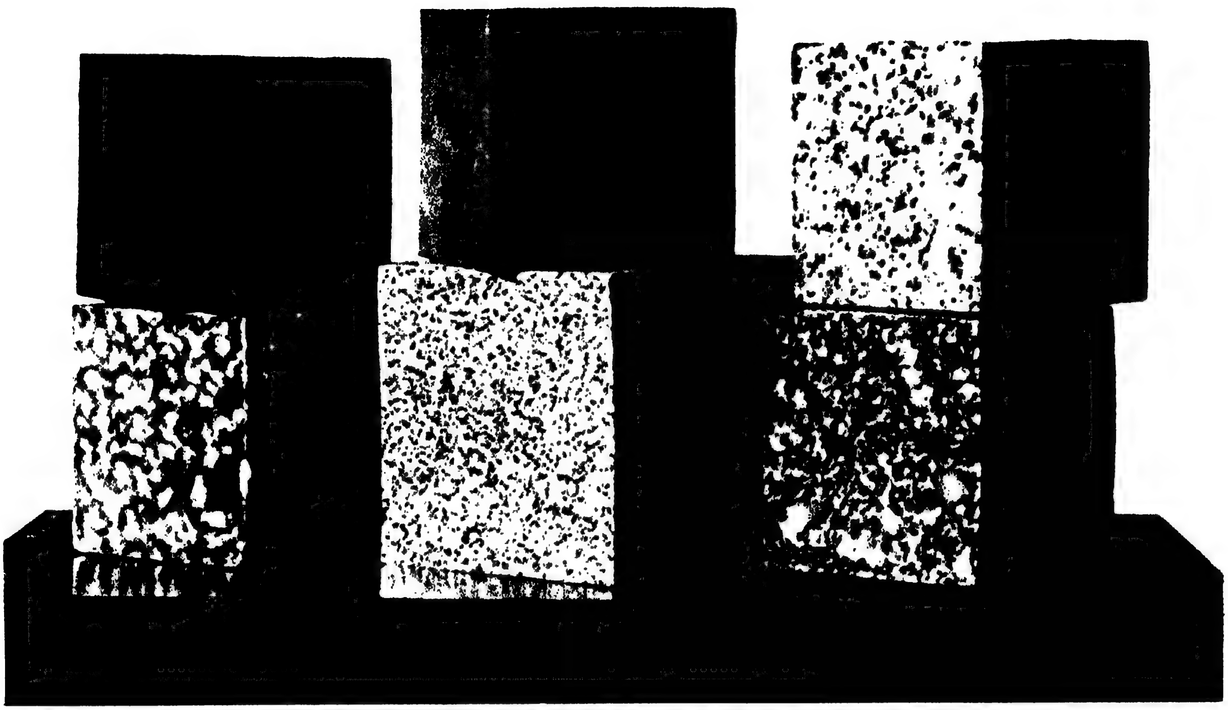
Orissa: Granite and gneissic rocks occur in the Eastern Ghats and in Sambalpur, the former containing much garnetiferous gneiss. Upper Gondwana sandstones found near Cuttack are of fairly good quality for building and for carving, as can be inferred from the architecture of the Buddhistic caves of Kandagiri, which have withstood the weathering of several centuries.

Tertiary sandstones are found in the coastal dists., often capped by a small thickness of laterite. The laterite can be used as a building stone, whereas the sandstone is generally of poor quality.

Punjab: Both the purple sandstone and magnesian sandstone of the Salt Range are used as building stones in Jhelum dist., the latter being quarried at Jutana (32° 43′: 73° 13′). Murree sandstones used in Udhampur dist. are fairly compact and strong, while Nahan sandstones are usually not so good. Massive sandstones of good quality are won in the sub-Himalayan region of Simla at Rajawas (28° 18′ : 76° 7′) and Khaspur (28° 7′ : 76° 12′), while schistose quartzites splitting into comparatively thin slabs are quarried in the hills west of Begopur (27° 56′: 76° 7′). The Sanjauli quartzites of the Simla neighbourhood are also good building stones.

Thin beds of calcareous tufa (spring deposits) are quarried, dressed and used locally as building stones. They are serviceable, though not strong or very durable.

Some of the Permian and Nummulitic limestones of the Salt Range can be polished and used as de-



GRANITES FROM MYSORE

corative stones. Suitable Permian limestones occur at Warcha and Katha, while good Nummulitic limestone is quarried at the Sardi glen.

White, black, and banded marbles are quarried near Narnaul, in the Mandi and Datla hills (28° 3′ : 76° 8′), Makandapur (27° 59′ : 76° 8′), and near Islampur (27° 55′ : 76° 6′) in Patiala State. White marbles are available at Biharipur (27° 55′ : 76° 8′) and Dhonkora (27° 51′ : 76° 6′). Limestone is quarried for building purposes at Prospect Hill near Simla. Marble has also been reported from Mandi State.

Slates are extensively quarried near Kund railway station (28° 9′: 76°27′) in Gurgaon dist., and near Dharmsala in Kangra dist.

The slate quarries near Kund are being worked by the Kangra Valley Slate Company. Slates of varying sizes, chiefly for flooring, and roofing down to ⅛″ thickness are prepared. This company and the Bhargava Slate Company are the chief mining concerns, working the slate quarries near Dharmsala. The principal quarries of the former are situated at Kanhiara (32° 12′ : 76° 24′). Kangra slates are locally used as roofing slates, and are also exported to places outside the district (Chandoke, *Trans. Min. geol. Inst. India*, 1933, **28**, 161).

Rajputana (Heron, *Trans. Min. geol. Inst. India*, 1935, **29**, 304): Granites and gneisses are abundant in Rajputana—the Banded Gneissic Complex, Bundelkhand Gneiss and later intrusions—but they are not much used as other and more easily worked materials are available.

There is a quarry, producing a pink hornblende granite at Jasai (25° 40′ : 71° 20′) in Jodhpur; this rock takes a good polish and is quite durable.

Some of the silicified Aravalli schists are locally used for building at Adera and other places in Ajmer-Merwara. Good slates are worked near Kund (28° 9′ : 76° 27′); they are indurated shales and not true slates, as they split along bedding planes. Inferior slates are worked at Pinangwan (27° 54′ : 77°10′) and near Mandan (28° 6′ : 76° 26′) in Alwar State. Flaggy slates are worked at Garara (24° 5′ : 74° 21′) in Mewar, which yield slabs up to 6′×3′, and 4″ in thickness. Finely laminated slaty flags are available near Salimpur (27° 6′ : 77° 2′) in Jaipur State.

Micaceous quartzites of Alwar and Ajabgarh series are quarried in many places. Vindhyan sandstones are worked and exported to neighbouring provinces. They are reddish-brown in colour, often spotted and streaked with fawn, but stones with uniform light-pink, red or fawn colour are also quarried. Their easy workability and satisfactory service are responsible for their great popularity. They can be obtained in various sizes and can be used in the shape of blocks for large scale buildings, flags for flooring and roofing, steps, fence posts, beams, pillars, etc.

A schistose micaceous grit from the base of the Delhi system is worked at Srinagar (26°26′ : 74°50′) and used largely at Nasirabad and Ajmer. It is easily quarried and dressed.

A quartzite of dark-grey to white colour, used for general building, is quarried at Berla (27°23′: 76°50′) and other places in Alwar. It can be carved roughly while fresh, and it hardens on exposure. It develops iron stains in course of time, but these are not objectionable, except for high class architectural work.

Micaceous quartzites are worked for use for different purposes such as flooring and roofing slabs, beams, etc. at Rajgarh (27°14′: 76°41′), Mokanpura (27°43′: 76°29′), etc. Slabs up to 9′×2′, and 2″ thick are quarried at Mokanpura, while the quarries at Kirwari supply the demand for a cheap building stone, as they are close to the railway.

Vindhyan (Upper Bhander) sandstones have been quarried for centuries at Rupbas (27°0′: 77°39′) and Bansi Paharpur (26°55′ : 77°34′) in Bharatpur State. The stones are reddish-brown with spots and streaks of fawn, or are uniformly fawn-coloured. The red stone is thin-bedded and is generally more durable, while the fawn variety yields massive freestone. The Bharatpur quarries are well known all over northern India.

The quarries at Dulmera (28°25′ : 73°43′), about 30 miles northwest of Bikaner, yield excellent red and brown sandstone of Vindhyan age, used extensively in Bikaner State.

At Umarthuna in Bundi State, Upper Vindhyan sandstone is quarried for building purposes and for flooring slabs. They yield slabs as large as 10′ square.

Freestones are quarried for slabs and for carving at Ragonathgarh (27°40′ : 75°24′) in Jaipur State. Flagstones are quarried from the Aravalli rocks near Bhan Kari railway station, Kalaotha (26°58′ : 76°29′), Jasrapura (28°2′ : 75°46′) and north of Amber (26°59′ : 75°55′).

Vindhyan sandstones are quarried in Jodhpur State at Sojat (25°55′ : 73°40′), Nagaur (27°13′: 73°48′) and Jodhpur. The white sandstone quarried at Khatu (27°7′: 74°21′) is used particularly for fine carvings including carved windows (*jalis*); on ageing, this stone takes on a warm yellow colour. The formation yields white slabs and freestone at Mokundwara (24°49′ : 76°2′) andKanwas (24°52′ : 76°10′) in Kotah State.

Though there are numerous occurrences of limestone and marble in Rajputana, the principal deposits are those of the Raialo series, quarried at Makrana (27°2′ : 74°45′) and Sarangwa in Jodhpur, and Rajnagar in Mewar.

Marbles occur at Odas (26°18′: 74°19′) and Sheopura (26°16′: 74°21′) in Ajmer-Merwara. The stone from Odas is of a pinkish-grey colour with faint striping, and free from flaws and joints. It is well-suited for use as dimension stone. Sheopura marble is pink and white, banded and saccharoidal. Parts of it are of green colour, showing patches and streaks of dark-green and pink. Some stones with fairly uniform green colour with cloudy whitish patches are beautiful, but bedding and joints are rather irregular.

Pure white marble is won at Beldeogarh (27°8′ : 76°26′), Jhiri (27°14′: 76°16′) and Dadikar. The first of these localities also contains a pink marble.

One mile to the west of Badgaon (27°32′ : 76°16′), on the Alwar-Jaipur border is found a banded black and white marble, well-crystallised and free from flaws. A very fine-grained marble from Umar (25°41′ : 75°28′) in Bundi State is well-adapted for fine carving and has been used in several carved tombs at Bundi.

The Raialo (27°5′ : 76° 7′) marble is an excellent, practically pure white, dolomitic marble. A mile and a half northwest of the place occurs a fine pale-grey variety. It is not so well known as Makrana marble, because it is far from the railway.

The celebrated Makrana marble of Jodhpur State is white, but generally clouded and streaked with grey, and quite durable. It occurs in four steep-dipping bands which can yield blocks up-to 10′×4′×4′ (wt., 180 lb. per c. ft.). It has a crushing strength of 3–4 tons per sq. inch. Numerous quarries are being worked, but generally in a rather primitive and wasteful manner.

The marble of Sarangwa (25°17′ : 73°33′) in Jodhpur is coarser than Makrana marble, and also less durable in exposed situations. It is bluish with yellowish bands and not very attractive.

A large area is occupied by marbles around Rajnagar (25°4′ : 73°55′), Nathdwara (24°56′ : 73°52′), Kankroli (25°3′ : 75°57′), and Kelwa (25°9′ : 73°53′). Rajnagar marble is pure white, but some fine pink and salmon coloured varieties are also available, especially in the areas south of Udaipur city where the above mentioned marbles have been used.

Good white dolomitic marble, similar to Rajnagar stone is quarried at Lawa (25°14′ : 74°6′) and Kosithal (25°19′ : 74°13′). Good coloured marbles are available at Devi Mata (24°24′ : 73°45′), Kalakot (24°29′ : 73°45′), Babarmal (24°25′ : 73°46′) and Pangamra (24° 0′ : 74° 8′) in Mewar State, but they are not easily accessible. White marble capable of taking good polish occurs near Ambamata town in Danta State.

Marbles of Ajabgarh age are quarried at Tonkra (26°39′ : 74°55′), Narwar (26°36′ : 74°44′) and Jak (26°57′ : 74°56′). The first of these quarries yields a dull white stone with brown stains, while that at Narwar yields fine pink marble. Grey and black marbles are quarried at Jak. The Baislana (27° 39′ : 76° 9′) marble is dark-grey and often banded, and is used for building and for making a variety of objects.

A fine-grained beautiful marble of uniform quality and of warm yellow colour is quarried at Jaisalmer (26°52′ : 70°55′), where it is much used. The Abur (27°5′ : 70°37′) stone is a fine red to reddish-brown fossiliferous shell marble, used for fine carvings and is much favoured for use in temples in northern India.

Sind : Some good sandstones are found in the Nari beds in a few places. The later Manchhar beds yield softer and less durable stones.

Good limestones are plentiful in the Eocene beds, exposed in the hills of western Sind. A fine yellow to brown limestone of Ranikot age is got at Jhirak

(25°5′ : 68°19′), while a porous stone of Gaj age is used fairly commonly at Karachi.

United Provinces : Granites and gneisses are found mainly in the Himalayas. A pale-grey gneiss occurs at Ranikhet (29°38′ : 79°29′) and a porphyritic grey granite near Almora (29°36′ : 79°43′). Good quartzites are also obtainable at Almora.

Slaty shales, not properly cleaved, are available at Chiteli (29°49′ : 79°28′) in Almora dist. Good slates are said to occur at Lohughat (29°24′ : 80°9′) in the same district, and also in Jaunsar and in the valley of the Algar river, north of Mussoorie.

Sandstones of excellent quality are available both in the lower and upper Vindhyans. Kaimur sandstones are quarried extensively near Mirzapur (25°9′ : 82°37′), and Chunar (25°8′ : 82°57′), etc. They are fine-grained, yellow, pale red or greyish and sometimes spotted, and are used extensively for paving and building. Large blocks and slabs can be quarried.

Upper Vindhyan sandstones are obtainable in Allahabad and Agra dists. and are worked particularly near Fatehpur Sikri and Pargana Sarhindi. The quarries extend into Bharatpur State. The stones are generally red or grey, and quite durable.

MINING AND PREPARATION

Though stones suitable for use as building materials are abundant over very large parts of the surface of the earth, areas containing good materials of uniform quality, and with desirable properties are very limited. The opening up of a quarry for systematic production of building stone requires, therefore, a preliminary geological examination in order to ensure sound development.

Open and good exposures of fresh stone are to be examined first ; in their absence, overburden must be removed and fresh rock exposed, so that the properties of the stone can be studied—strength, durability, presence and distribution of cracks and joints, colour, texture, etc. Wellspaced joints and their intersection in directions at right angles to each other will enable the quarrying of large rectangular blocks, which require only limited dressing before use. For decorative work and monuments, stones must be artistically attractive, capable of taking good polish and of being easily worked with chisels and cutting tools.

In Western countries, where stones are quarried or mined on a large scale, initial exploration may be done by drilling. In most cases, a spacing of 50–100 yards is considered sufficient. In the case of stones which are not uniform, closer spacing may be necessary.

Most stones are won by quarrying, though occasionally some marbles and slates are mined by underground methods. The removal of overburden may be done hydraulically, where there is ample supply of water, and where the ground is favourable for the disposal of the waste. Mechanical scrapers, excavators, and power shovels are often used in Europe and America.

Granites have generally joint planes, parallel to the surface and in two other directions, which are availed of in quarrying. The planes parallel to the surface are called 'sheeting planes'. The direction of easy splitting (parallel to one set of joints) is called the 'rift', while another, which is somewhat less easy and usually at right angles to the former, is called the 'grain'. Granite quarries are opened as trenches, taking advantage of the system of joints. Light explosive or black powder may be used, when necessary, to loosen blocks.

Rough finishing is done by pneumatic (compressed air) tools. Stones with such a finish are used as kerb stones and for paving. Rough finish is given by hammer heads of various patterns. Carving is often done by sand-blasting, by covering the stone with an elastic rubber-like film and then cutting out the required pattern, and exposing it to sand-blast. The sand-blast can be adjusted to do even quite delicate work and it is much quicker than hand-carving.

Stones for facing, such as for walls and pillars can be cut by straight or circular saws. fed with chilled steel shot as abrasive. By this means, stones can be cut in such a way as to give them the best decorative effect.

The polishing of granite is done in two or three stages, first using steel shot and later carborundum. The final stage, called 'buffing' is performed by soft revolving pads using tin oxide or other fine material as polishing medium.

The quarrying of limestone is done by channeling machines, mounted on a frame and travelling to and fro along a definite track. A narrow channel or trench is cut by means of steel bars,

which act like drills. The cuts made by these machines are usually 4′ apart and 8–12′ deep. There are also channeling machines, capable of making double cuts.

A more recent development is the 'wire-saw' which is a three-strand endless steel cable (¼" diameter). The wire is guided along the plane of cutting by suitably placed standards with pulleys, the cutting agent used being silica sand, fed with water. The use of wire-saw is becoming very popular for limestone and marble quarrying, as it is generally cheaper than work by channeling machines, and can be used even in difficult situations.

Dressing in the factory is done by steel saws, discs and planing machines. Lathes are also used, especially for shaping columns, balustrades and various other special shapes. Machines have been developed for cutting and shaping intricate patterns. Surface finishes are given by various types of tools, white carving can be done by sand-blasting.

Both open quarrying and underground mining are used in winning marble. Open quarries are worked as in the case of other rocks, but special care is necessary when opening up underground mines in order not to spoil the marble bed. It is usually only particular beds or zones that are of value as marble. The channeling machine is used for quarrying both on the floor and on the roof of the mine. Wire saws also are used.

The large blocks first isolated in the mine are reduced in size by drilling and wedging. At the mills, they are sawn into slabs or small blocks which are given different finishes on rubbing beds and finally polished, if necessary. Rubbing beds are circular revolving discs of some hard material, the abrasive being carborundum or silica sand, fed with water. Polishing is done by a revolving disc or head supplied with tin oxide as polishing medium. Carving is mostly done by sand-blasting.

Sandstones can be quarried by ordinary drilling and blasting or by channeling machines. The blocks are cut, shaped and finished as in the case of granite. Grindstones and pulp-stones are cut by means of circle-cutting drills, or shaped from quarried blocks. Special shapes are cut and carvings executed in the same way as with granite or limestone.

Sandstones are used as kerb-stones, paving stones, flagstones, water tubs, grindstones, etc., while hard and highly siliceous varieties (quartzites) are used for drilling furnaces, and grinding mills, and as balls in ball-mills.

The high cleavability of slate requires some care in quarrying to avoid much waste. Preliminary drilling in the quarry is followed by wedging. Channeling machines and wire-saw are used in American quarries.

Underground mining is practised in some places in the British Isles (Wales) and Germany, where some good beds have been located at too great a depth for open cast quarrying. Waste in the quarrying of slate is much higher than in the case of other stones. The quarried blocks are removed to preparation sheds, where they are split into layers of required thickness by means of thin broad wedges. Mechanical splitting is not so satisfactory as manual splitting.

Slates are cut to size by circular steel saws and planed by mechanically run straight knives or on rubbing beds. Slate for structural purposes is often treated with oil compositions or colloidal iron and manganese compounds, or they may be stained or enamelled.

PRODUCTION

The building stone industry in India is mostly conducted in primitive fashion by numerous small producers. Very little machinery is used in quarrying or in preparation, and practically all operations are conducted by manual labour. Neither is marketing done on systematised lines.

Building stones are also handled through retail trade channels, except where the consumers require large quantities, when they may be supplied direct from quarries. Much ornamental stone passes through middlemen and retailers, who supply small quantities to special specifications, and for monuments, etc.

The accompanying table gives a rough idea of the output of various types of stones in 1944. They are, however, far from complete, for they do not include stones quarried casually for local use. Neither does the output relate only to building stones, for in almost every item figures of production of material used even as road metal are included. In the case of limestone (and *kankar*) the figures include the material used for making lime and cement.

Because of the bulk and cheapness of building stones they cannot be moved over a long distance, unless special shipping facilities are available. Hence it is only the more valuable stones, used for ornamental purposes, that figure in international trade, especially certain granites, gneisses, marbles, serpentines and slates.

Some foreign stones, especially Grecian and Italian marbles, are able to compete with Indian stones within a small radius of the principal ports. The areas which can supply similar stones in India are in the interior and freights are too large an item to allow their competing with imported stones. But the marbles of some parts of India, especially Rajputana, are certainly as good as imported ones in quality. The marble of Makrana has been used in the Victoria Memorial in Calcutta. Special efforts were made to quarry the necessary quantities, and the railways carried the material free to Calcutta.

Some organisation is evident in the trade in Vindhyan sandstones of Bharatpur, and of the United Provinces, and in the Mysore granite. A great deal remains to be done to improve all phases of the industry from quarrying to marketing.

PRODUCTION OF BUILDING STONES IN INDIA IN 1944

	Granite		Slate		Laterite		Limestone & Kankar		Sandstone		Marble	
	Tons	Rs.	Tons	Rs.	Tons	Rs.	Tons	Rs.	Tons	Rs.	Tons	Rs.
Assam	14	137	..	..	13,168	45,863	53,735	91,179	14	90	..	..
Bengal	11,010	46,065	..	..	..	..	33	22	..	..	..	..
Bihar	6,07,148	18,64,121	365	5,225	..	..	6,70,739	19,79.787	16,879	36,229	..	..
Bombay	..	..	..	..	30,920	32,274	1,777	2,550	..	..	..	..
Central Provinces	4,232	20,229	..	..	..	..	5,11,955	12,06,726	..	..	..	..
Central India	..	..	..	..	..	..	73,313	3.33,316	..	..	..	..
Eastern States Agency	..	..	..	..	..	..	8,44,775	21,23.972	..	..	..	..
Gwalior	..	..	..	..	..	..	98,474	1,17,241	3,230	15,000	..	..
Kashmir	..	..	..	..	..	..	147	2,000	..	..	..	..
Hyderabad	..	..	..	..	..	..	2,68,003	9,71,198*	..	..	..	..
Madras	7,07,947	2,12,900	..	..	7,51,106	53,158	2,65,177	17,54,557	..	..	..	..
Mysore	..	..	..	..	94	28	38,626	1,75,779	..	..	..	..
Orissa	..	..	..	..	240	60	205	8,352	..	..	..	..
Punjab	1,73,353	5,75,487	5,961	159,714	..	..	4,36,517	5,28,500	3,930	12,500	..	..
Rajputana	..	..	..	..	..	..	4,41,569	10,23,774	3,71,422	11,57,832	18,200	3,06,146
Sind	..	..	..	..	..	..	3,62,027	2,96,213	..	..	..	..
United Provinces	1,31,959	3,41,128	20	15	..	..	11,50,968	11,95,980	..	..	..	..
N. W. F. P.**	..	..	..	..	..	..	..	..	..	..	404	8,250
TOTAL	16,36,563	30.69,967	6,346	1,64,954	7,95,528	1,31,383	52,18,100	1,19,01,146	3,95,502	12,21,651	18,604	31,439

* Estimated.

** for 1944-45.

Bullock's Hearts, see **Annona reticulata**

BUPLEURUM Linn. UMBELLIFERAE

D. E. P., I, 546 ; Fl. Br. Ind., II, 674.

A genus consisting of about 100 spp. of herbs, distributed in Asia, Africa, Europe and North America. 13 spp. are present in India. The roots of *B. falcatum* Linn. and *B. jucundum* Kurz are reported to be used for liver troubles and stomach complaints (Kirt. & Basu, II, 1198).

Bur-weed, see **Xanthium strumarium**
Burr-stones, see **Millstones** and **burr-stones**

BURSERA Linn. BURSERACEAE

The genus includes about 45 spp. of balsamiferous trees or shrubs, found mostly in tropical America. *B. gummifera* Linn., known as the Turpentine tree, furnishes the balsam resin, American elemi. *B. aloexylon* Engl. [=*B. glabrifolia* (H.B.K.) Engl.] and *B. delpechiana* are the source of Mexican linaloe or lignaloe oil. *B. tomentosa* Triana & Planch. of Venezuela yields Tacamasha resin, used in medicine, incense, etc.

B. delpechiana Poiss. ex Engl.=*B. penicillata* (Sesse & Moc. ex DC.) Engl.

THE LINALOE OR LIGNALOE TREE

A medium-sized tree, bearing numerous reddish-brown berries of the size of large peas. The wood and berries are highly aromatic.

The tree is indigenous to Mexico. It is hardy and grows well on rocky soil. Due to the enterprise of two Scotchmen, Mr. P. J. Anderson and his brother, a successful plantation of about 120 acres of this species has been recently established at Tatgunni, about 11 miles from Bangalore. The plants were first raised from seeds collected in Mexico, and later propagated by means of cuttings.

In Mexico, linaloe oil is distilled both from the wood and berries of wild trees, most of the supplies being obtained from the former. The oil is a colourless to pale yellow liquid of pleasant odour, much used in modern perfumery, and the total production of Mexican oil is 12,000–15,000 lb. per annum.

The oil is best distilled from the wood of trees 40–60 years old. The yield in Mexico is reported to be 2·5–3%, but when distilled in Europe, the wood from older stems is stated to yield 7–9%, and sometimes even 10–12%. The lower yields in Mexico are due to crude methods of distillation.

In the case of young trees, an attempt is often made to increase yield by wounding the stem. Strips of bark and wood are removed, parallel or diagonal to the axis of the stem. The increased yield of oil is to be regarded as a pathological phenomenon.

The essential oil in berries is contained entirely in the outer pericarp or husk. Previous to distillation, Mexicans subject the berries to a process of fermentation. This is said to increase the yield of oil, to remove its herbacious odour, and to improve its keeping qualities. The oil from the berries is not sold as such, but is added to the oil from the wood, which has better keeping qualities. The yield is about 3%.

In Mysore, as the trees are still young, oil is distilled only from the husks of berries. The yield has been reported to be as high as 18%.

The main constituent of Mexican linaloe oil is linalool (60–70%). Along with this are found smaller quantities of linalyl acetate, geraniol, α-terpineol, methylheptenol, linalool monoxide, etc. The oils from the wood and from the berries are similar in composition and odour, and show variations in optical rotation (Wehmer, II, 651).

The Mysore oil distilled from the outer husk of berries, contains a much lower percentage of free linalool and a much higher percentage of linalyl acetate than the Mexican oil (*Bull. imp. Inst., Lond.*, 1931, **29**, 182) :

Constants	Mysore linaloe oil I*	Mysore linaloe oil II§	Mexican linaloe oil*
1. Sp. gr./15·5°	0·8989	0·8952	0·875–0·891
2. [α]/20·5°	–4·68	..	–3 to–14°, but sometimes dextrorotatory (up to +8°).
3. n/20°	1·455	1·466	1·460–1·465
4. Acid val.	0·7	Nil	up to 3
5. Ester val.	216·7	130	1–42
6. Sol. in 70% alcohol at 15°.	Sol. in 3·3 vols.	..	Sol. in 1·5–2 vols.

**Bull. imp Inst., Lond.*, loc. cit.; § Narayan and Dutt, *Indian Soap. J.*, 1945 (Jan.-March), 50.

According to Narayan and Dutt (*loc. cit.*) the Mysore oil contains: linalool, 47·7; linally acetate, 40·8; methylheptenol, 1·5; sesquiterpenes, etc., 8·0 per cent.

The Mysore oil has usually a high ester content and a sample of Mysore oil examined at the Imperial Institute consisted mostly of linalyl acetate. It is reported to resemble Cayenne linaloe oil. Its staying power is superior to that of ordinary Mexican oil. As a fixative, it is equal to Cayenne linaloe oil, employed in transparent soaps.

The average production of the oil from the Tatgunni Estate at present is about 6,000–7,000 lb. per annum, of which normally 1,000 lb. are sold in the Indian market, and the rest exported, chiefly to London. The price of oil, which was Rs. 12 per lb. in 1941, is now about Rs. 32.

In many parts of Mexico, the wood of *B. delpechiana* is made into toys and furniture.

BUTEA Koenig LEGUMINOSAE

A genus of trees and large woody climbers, including 4 spp., distributed in tropical Asia. Three species occur in India.

B. monosperma (Lam.) Kuntze Syn. *B. frondosa* Koenig ex Roxb. THE FLAME OF THE FOREST

D. E. P., I, 548; C. P., 189; Fl. Br. Ind., II, 194; Pl. XXXVI.

SANS.—*Palasha*; HIND.—*Dhak palas*; BENG. & MAR.—*Palas*; GUJ.—*Khakra* TEL.—*Moduga*; TAM.—*Parasa*; KAN.—*Mutthuga* MAL.—*Palas in samatha*.

A medium-sized deciduous tree, with a somewhat crooked trunk, 10–15′ in height and 5–6′ in girth. The bark is bluish-grey or light-brown and yields a gum. Its bright orange-red flowers (1·5–2″ long) bloom in great profusion at the beginning of the hot season before the appearance of new leaves. The pod contains a single seed ($1'' \times \frac{3}{4}''$) at its apex.

Palas is common throughout India, Burma and Ceylon (up to 4,000′), except in very arid parts. Generally, it grows gregariously on open grasslands and scattered in mixed forests along with *Sal* (*Shorea robusta*). It is frost-hardy and drought-resistant and is a valuable species for reclaiming saline soils.

Plantations can be raised both on irrigated and dry lands. The pods should be collected and sown before the commencement of rains, in lines 10–12′ apart for ordinary afforestation, and 20′ apart for lac cultivation. Root suckers are freely produced and help in vegetative propagation.

In India, *palas* ranks next to *kusum* (*Schleichera trijuga*) as a host-tree for the lac insect. Although the quality of lac produced on *palas* is not so good, the quantity is greater than on any other species. Trees are pollarded in May. This leads to the production of a large number of succulent shoots and facilitates the collection of the lac crop, as all the shoots can be lopped off at the same time. Generally, the trees are infected with the lac brood during Oct.–Nov. About 2/3 of the crop is cut during April–May, and the rest is left over for natural infection in July. The new crop is completely harvested in the following Oct.–Nov. *Palas* brood may be utilised to inoculate *ber* (*Zizyphus jujuba*) and other lac hosts, but it should never be used on *kusum* (Glover, 75; Troup, I, 257).

A red juice exudes from natural cracks and artificial incisions in the bark, and it hardens into a vitreous, ruby-red gum, known as 'Butea gum' or 'Bengal kino'. It is distinguished from Malabar kino from *Pterocarpus marsupium* by its greater solubility in water, and by the presence of corky particles. Butea gum contains a large proportion of tannin and mucilaginous material. On dry distillation, it is reported to yield pyrocatechin. It is a powerful astringent and is given in many forms of chronic diarrhoea (Dymock, Warden & Hooper, I, 454).

The seeds have long been valued as anthelmintic. Birdwood (41) prescribes them for round worms and tapeworms. According to Chopra (306) freshly powdered new seeds give fairly good results against *Ascaris*, but old worm-eaten ones, like those frequently found in the market, show little activity. The oil, powdered seeds, and an alcoholic extract of seeds, proved quite ineffective against hookworms, etc. When pounded with lemon juice and applied, the seeds act as a powerful rubifacient and they have been successfully used in curing a form of herpes, known as dhobie's itch (Dymock *et al.*, *loc. cit.*).

The seeds contain 18% of a yellow, tasteless oil (sp. gr. 25°/25°, 0·8983; sap. val., 178; iod.val.,

67·2, Katti and Manjunath, *J. Indian chem. Soc.*, 1929, **6**, 639). Fresh seeds are reported to contain proteolytic and lypolytic enzymes. The former is a mixture of plant proteinase and polypeptidase, and behaves like 'yeast trypsin' (Chatterjee, Ghose and Chopra, *J. Indian chem. Soc.*, 1938, **15**, 101, 107).

The flowers yield a brilliant but very fugitive yellow colouring matter. This is contained in the sap and may be obtained in the form of a decoction or infusion from dried flowers. The addition of alum, lime or an alkali deepens the colour to orange and also makes it less fugitive. The sap contains the chalcone, butein $C_{15}H_{12}O_5$ (0·3%), orange yellow needles, m.p., 213–215°, and small quantities of butin, the colourless isomeric flavanone, and its glucoside, butrin (Hummel & Perkin, *J. chem. Soc.*, 1904, **85**, 1463; Lal and Dutt, *J. Indian chem. Soc.*, 1935, **12**, 262; Murti & Seshadri, *Proc. Indian Acad Sci.*, 1940, **12 A**, 477).

Palas wood is white or yellowish-brown, but very liable to sapstain and often turns greyish-brown or grey. It is a light wood (sp. gr., 0·54; air-dry wt., 34 lb. per c. ft.) and can be seasoned without much difficulty, but it contracts considerably during seasoning. It is not strong or durable in exposed situations, but is said to last much longer under water. It is easy to work either by hand or machine, and is used mainly for well-curbs water-scoops and for fuel. It can also be employed as a cheap board-wood (Pearson and Brown, I, 359). In the Central Provinces, it is used to a small extent for structural work. The chief drawback which prevents more extensive use of the wood is the short length of logs and their irregular shape.

The leaves are much used throughout the country for making platters, cups, etc. They are eaten by buffaloes and elephants. In Madras and Bengal, the dried leaves are used for *beedi* wrappers (Jagdamba Prasad, *Indian For. Leafl.*, No. 60, 1943, 4). Young roots are reported to yield a fibre, which is used for making ropes, etc. in certain parts of central India. Dry twigs are used to feed the sacred fire (*hom*).

B. superba Roxb.

D. E. P., I, 566; Fl. Br. Ind., II, 195.

SANS. & BENG.—*Latapalasha*; HIND.—*Palas lata*; MAR.—*Belia palas*; GUJ.—*Velkhakar*; TEL.—*Thiga-moduga*; TAM.—*Kodi marukkan*; KAN.—*Balli mutthuga*.

An extensive woody climber, with gorgeous orange-scarlet flowers, found wild in forests over a large part of the country, from Oudh eastwards through Bihar and Bengal to Assam, and southwards to Burma. It is a common climber in the hill forests of central and south India. By its heavy growth, it tends to crush the trees on which it grows.

A gum-kino, very similar to that obtained from *palas*, exudes from its stem. The root and the young branches yield a strong fibre, which is made into ropes in central India. The leaves are eaten by cattle.

Butter, see **Dairy Products**

BUXUS Linn. BUXACEAE

A genus of 20 spp. of evergreen shrubs and trees, distributed from central Europe and the Mediterranean region to southern Asia, central America and the West Indies. *B. sempervirens* Linn. is the European species which yields boxwood. Two distinct forms occur in India: *B. papillosa* C. K. Schneider and *B. wallichiana*. The former is a large shrub or a small tree and is found in the outer Himalayas at 2,000–4,000′ from the Jhelum westwards. Its wood is similar to that of the latter species, but owing to the crooked nature of the stem, it is used only for fuel. The wood of *B. wallichiana* is indistinguishable from that of *B. sempervirens*.

B. wallichiana Baill. Syn. *B. sempervirens* Linn. (in part). THE BOXWOOD TREE

D. E. P., I, 556; Fl. Br. Ind., V, 267; Parker, 448.

KASHMIR—*Chikri*; PUNJ.—*Shamshad*. TRADE—Boxwood.

A shrub or small tree reaching 30′ in height and 4′ in girth. It is found in the western and central Himalayas at a height of 4,000–9,000′, and also in Bhutan. The trees are found growing gregariously in patches, usually in moist, shady ravines, but distribution is very local.

The leaves, which are occasionally browsed upon by goats, and in times of scarcity by other animals, have been reported to have proved fatal to cattle. The wood and leaves taste bitter, probably due to the presence of alkaloids like buxine, which

have been found to be of general occurrence in species of *Buxaceae* (Martin-Sans, *Chem. Abstr.*, 1931, **25**, 3123).

B. wallichiana yields timber of the first class. It has an uniformly light yellow to brownish-yellow colour with a silky lustre. Sapwood and heartwood are not distinct. The timber has no characteristic odour or taste. It is heavy (air-dry wt., 52 lb. per c. ft.), hard, extremely fine and even-textured, and works to an ivory finish under tools (Pearson and Brown, II, 871).

Boxwood is a very difficult timber to season. If suitable precautions are not taken, it develops many deep cracks. Pearson and Brown (*loc. cit.*) suggest the following methods for avoiding such cracks. (1) A saw-cut is made reaching the centre on one side of the billet. While seasoning, the wood will begin to contract only in the region of this cut preventing splitting elsewhere. (2) The logs are buried underground for several years, or stored in a cellar for 3–5 years. Sapwood is then removed and the logs are again stored underground for a year or more. (3) The billets are boiled and buried in sand, after they have become dry. (4) The tree is girdled, and when it is felled, the billets are split into halves and seasoned in a cool place.

Boxwood is durable and is not affected by many insect pests. It is easy to saw and is the finest wood for engraving, fine carving, turning and, for making drawing, geometrical and musical instruments. It is also used in India for the manufacture of small boxes to contain butter, honey, snuff, etc., and for making combs. In Europe it is also used for fine cabinet and inlay work, Croquet mallet heads and balls, roller skates, flax-spinners, etc.

There is a ready market for the wood and the chief centre of trade is Amritsar (Punjab). Supplies, however, are very limited and also difficult of access. The annual supply from Bashahar Division (Punjab) has been estimated at 20–25 tons, from Reasi Division (Kashmir) 175 tons, from Mirpur Division (Kashmir) 20 tons (Pearson and Brown, *loc. cit.*). The timber is sold by weight, and its value is determined more by its freedom from knots and splits than by the size of logs.

BYTTNERIA Loefl. STERCULIACEAE

Fl. Br. Ind., 1, 376.

A genus mostly of large woody climbers, comprising 60 species, distributed in warm countries, but chiefly in tropical America. 9 species are present in India.

In the Andamans, the mucilage from the bark of *B. andamanensis* Kurz, is employed as hair-wash (Parkinson, 102). *B. herbacea* Roxb., a large perennial herb, found in Orissa and the Deccan, is reported to be medicinal (Kirt. & Basu, I, 384).

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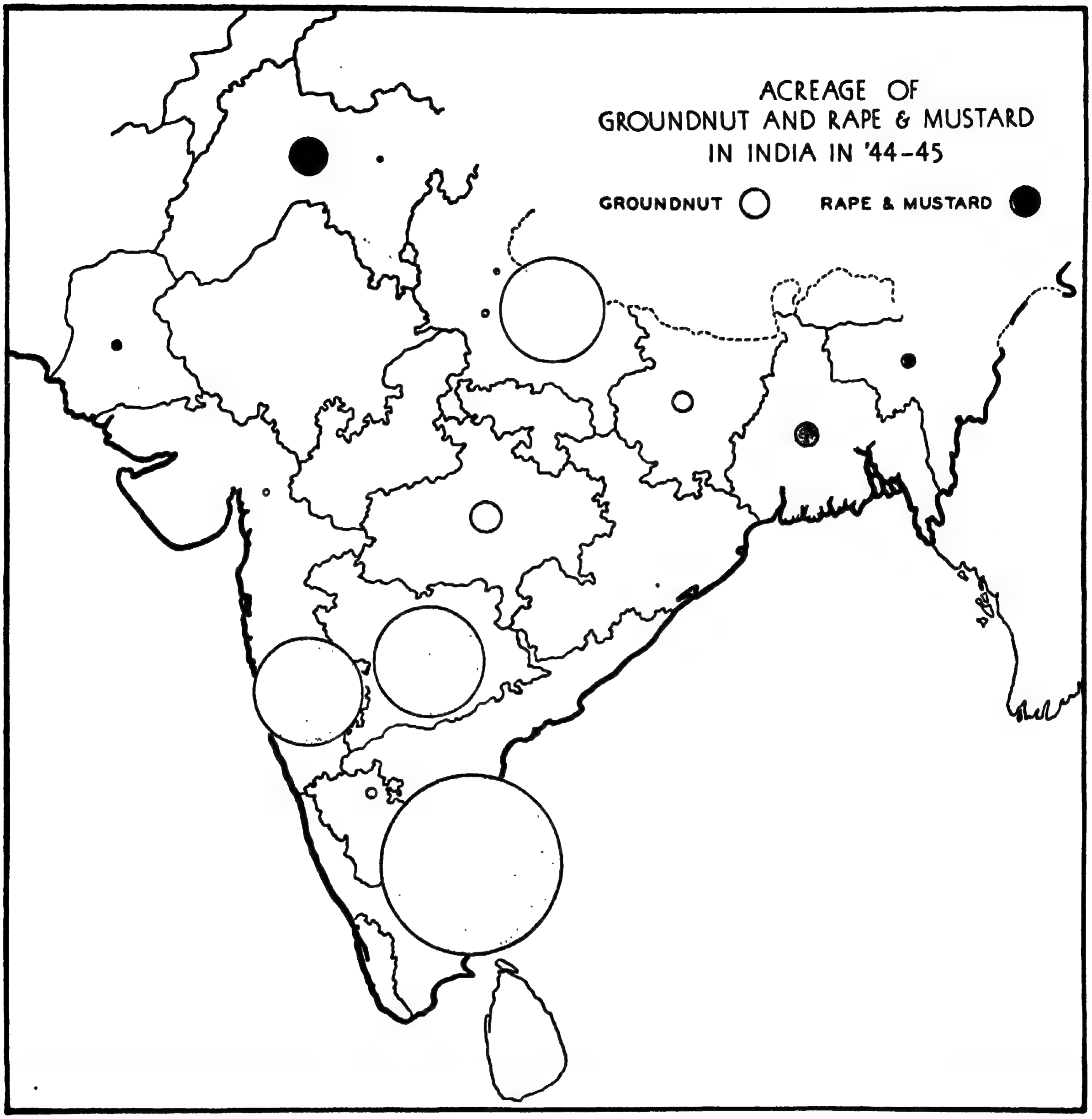

ACREAGE OF GROUNDNUT, RAPE AND MUSTARD IN INDIA, '44-45
(SCALE : 1 CM. DIAMETER REPRESENTS 2 MILLION ACRES)

ERRATA

Page	*Column*	*Line*	*In place of*	*Read*
v	..	14-15	Presidency College	University College of Science
2	1	44	Linn.	Linn. f.—
16	2	39	si	is
22	1	37	syining	shining
30	2	1	**ADANSONIO**	**ADANSONIA**
31	1	7	905·1	190·5
34	1	49	lakaloid	alkaloid
34	2	43	LEGUMINOSEAE	LEGUMINOSAE
35	1	5	witk	with
38	2	3	manufacture	manufactured
42	2	19	LEGUMINOSEAE	LEGUMINOSAE
52	2	12	CO_2	CO_3
52	2	40	53·59%	59·59%
57	2	48	1 041	1·041
58	1	2	**5**	**51**
68	1	20	2 5	2·5
72	1	36	40-53%	40-50%
85	2	42	30″	30′
86	1	11	13,500″	13,500′
95	2	42	mosure	measure
96	2	9	1,06,00,000	1,05,00,000
98	2	13	12-50%	15-20%
99	1	19	40-48%	40·48%
100	2	4	pressed	pressed
128	1	47	chrys ile	chrysotile
146	2	25	*Nectria* spr.	*Nectria* spp.
161	2	36	SiO_3	SiO_2
161	2	36	TiO_3	TiO_2
163	1	7	16°33′	16°3′
174	2	20	3-6′	3-6″
180	2	25	0-1%	0·1%
191	2	48	sanddipers	sandpipers
198	2	3	sylstem	system
210	1	34	**B. nitermedia**	**B. intermedia**
212	1	7	peren ial	perennial
215	1	last line	Table II	Table I
218	2	,,	Table II	Table I
220	1	39	5-3	3·5
222	1	43 (Sap. val.)	169-71	169-175
222	1	43 (Iod. val.)	96-108	96-104
222	1	44 (Sap. val.)	169-175	169-176
225	Table VIII	Last column	'43-44	'43-44§
226	1	21	1936	1938
236	2	34	2·175)	2·75 (
238	1	2	cvenly	evenly
241	2	38	59°45′	69°45′
245	1	8	76°8′	76°6′
251	1	2	linally	linalyl

TABLES

Page	Column	Table No.	Table Column	Table Line	In place of	Read
7	2	..	4	1	4·91	4·9
7	2	..	5	1	65·7	165·7
10	1	..	1	1	Moistu e	Moisture
10	1	..	3	2	54 7-60·0	54·7-60·4
10	1	..	3	3	6 4-11·0	6·4-11·0
18	1	..	5	2	14-10-0	14-1-10
51	1	..	4	1	16·6	16·0
54	..	..	3	1	2¾	2¼
73	2	..	2	1	0·9623	0·9823
78	2	..	2	2	14·943	1·4943
82	1	..	3	6	5 0	5·0
102	1	XII	3	4	81·00	1·00
150	..	IV	6	3	35·0	55·0
150	..	IV	7	3	5·9	3·9
201	..	..	9	2	67·42	67·44
201	..	..	9	3	34·19	34·14
201	..	..	9	4	28·34	28·32
201	..	..	9	5	58·84	58·89
206	..	..	3	2	1·73	1·03
214	..	II	4	4	170-176	172-176
223	2	III	7	1	100	10·0
223	2	III	..	Ref. (b) : page.	3	13
249	..	..	10	1	14	41
249	..	..	13	19	31,439	3,14,396